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SCIENCE

27 June 1958

Volume 127, Number 3313

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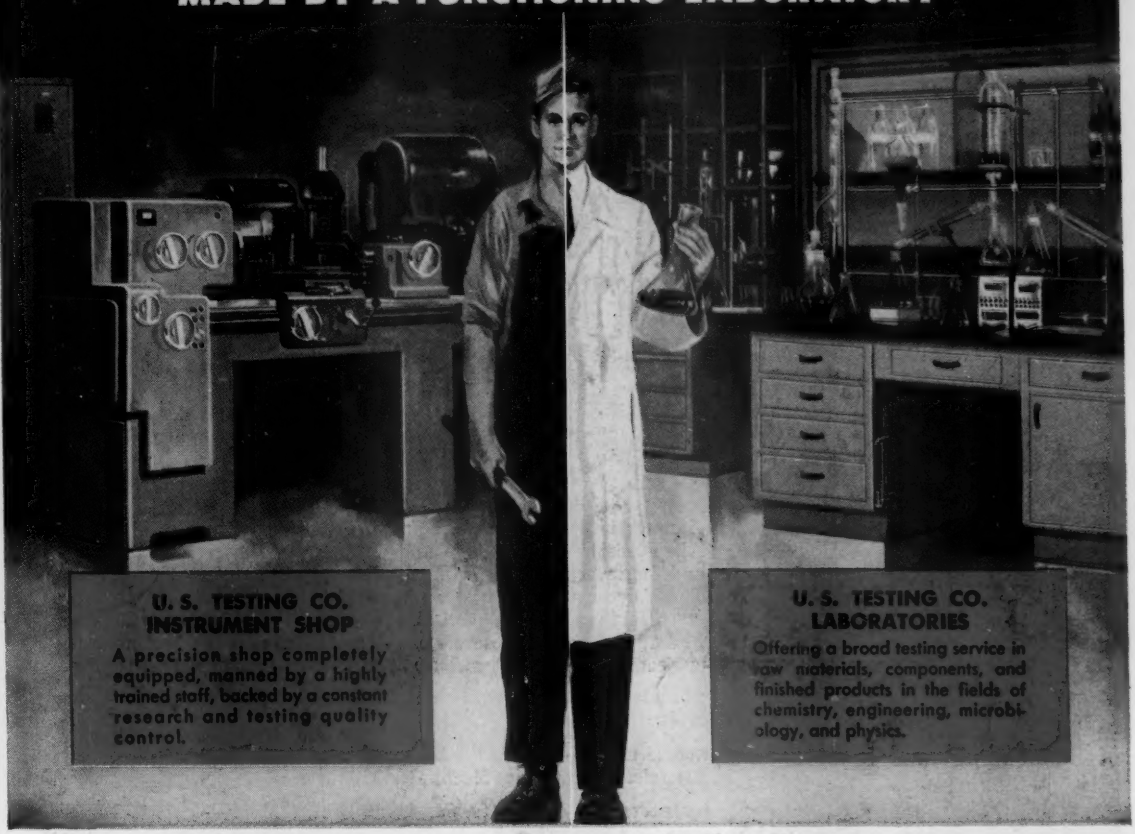
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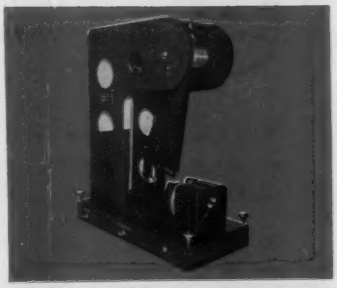

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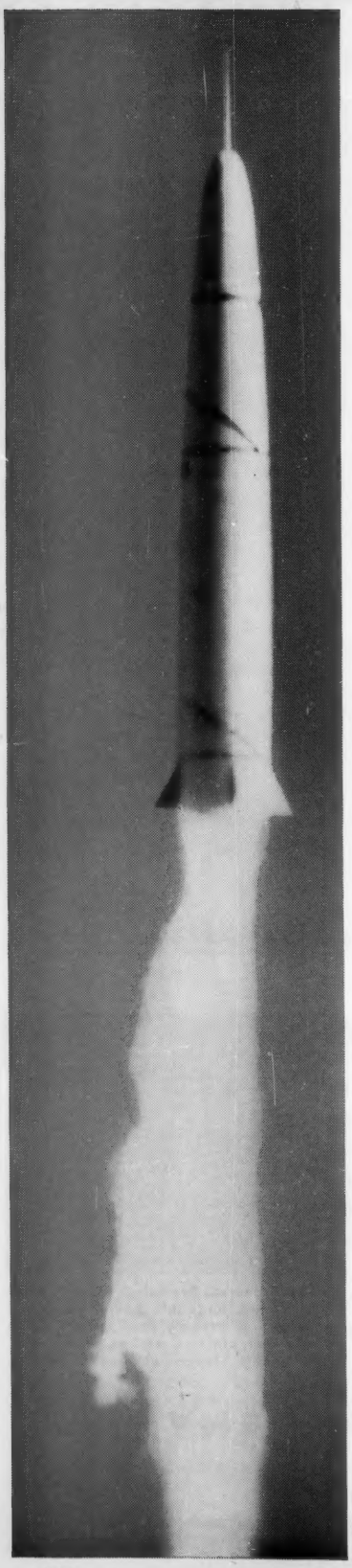

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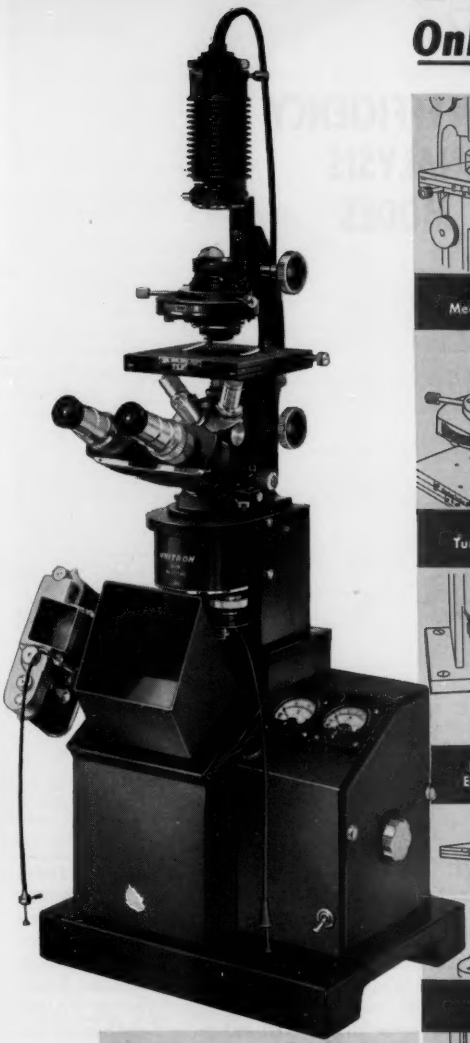

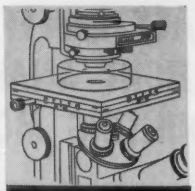

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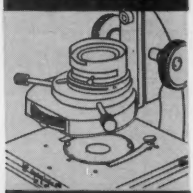

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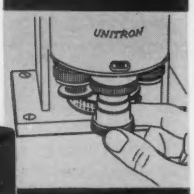

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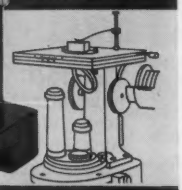

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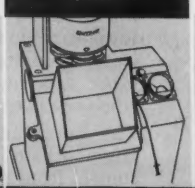

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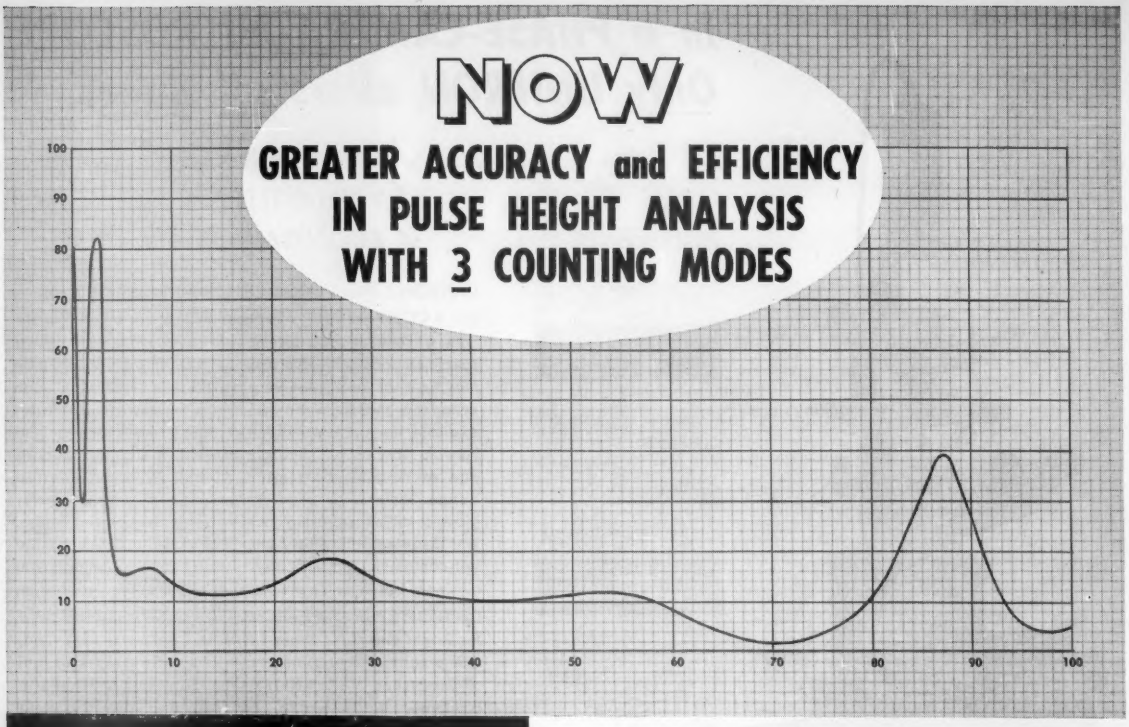

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Preserving the Stuff of History

Without papers and documents from the past, the historian of science would be helpless. Unfortunately, these valuable source materials are being destroyed at a startling rate in present-day America. Children today do not carry on a long family tradition, and heirlooms and papers kept for decades are being disposed of summarily.

Professor W——, for example, was a key figure in American science at the turn of the century. He carried out impressive research at one of our leading universities, founded an important journal, and organized one of our great research laboratories. His ideas were provocative and influential, and his pupils rose to eminent positions in the world of science. Yet today there exist no primary source materials relating to his work. His correspondence, notebooks, photograph albums, and manuscripts have disappeared.

What is needed to correct the situation is a Commission to Preserve the Private Papers of American Scientists. Whether the commission is set up as a private or government agency, its members would represent such institutions as the National Academy of Sciences, the Library of Congress, and the National Archives and such organizations as the Society of American Archivists and the History of Science Society. The commission would have a twofold task. It would be a central agency carrying on a systematic and comprehensive search for source materials for the history of science, and, in this regard, it ought to be empowered to establish a national history of science archives in Washington.

It is doubtful whether any single collection, however grand, can do the job on the comprehensive scale required. As its second, and more important task, the commission should take action to stimulate and coordinate the archival work of the present scientific institutions and organizations. It is not enough that we have the papers of an Einstein. We need material concerning the *hundreds* of top-notch men doing important creative work in theoretical science and in the applied fields—medicine, engineering, industry, and so on. And we cannot predict which of these men will be of greatest interest to the future. Each scientific and educational institution—be it a university, museum, library, or research laboratory—has a part to play in finding and storing papers of potential historical value. And every scientific organization should have collections of relevant data at the national, regional, and local levels.

The heroic age of American science began shortly after the Civil War and reached its climax just after World War II. These years, during which we won a position of world leadership, will be of unique interest to future historians of science. Already we have let much of this rich heritage slip through our fingers. A strong and active commission of the kind proposed can still repair some of the damage. But time is running out.

GERALD J. GRUMAN

History of Science Department, Harvard University

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In 1948, Bell Telephone Laboratories announced the invention of the transistor. In 1958, the transistor provided the radio voice for the first United States satellite.

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1958—*Satellite transistor, incorporating 10 years of Bell Labs research and development.*

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Moondust

The study of this covering layer by space vehicles may offer clues to the biochemical origin of life.

Joshua Lederberg and Dean B. Cowie

Lacking an appreciable atmosphere, the moon may seem to offer little opportunity for biological research. However, astronomers suppose that the moon is covered by a layer of dust of great antiquity (*1*). This dust is cosmic material captured by the moon's gravitational field and presumably left undisturbed by atmospheric and biological alteration. It should therefore contain a continuing record of cosmic history as informative with respect to the biochemical origins of life as the fossil-bearing sediments of the earth's crust have been in the study of its later evolution.

For the biologist, this dust may furnish two striking opportunities: (i) to assess the prebiotic synthesis of organic compounds and (ii) to make an empirical test of cosmic dissemination of biospores [Arrhenius' *pan*-spermia hypothesis (*2*)]. The scope and uniqueness of these opportunities demand a cautious approach to the planning of space missions lest they be prejudicial to later scientific study.

Prebiotic Synthesis of Organic Molecules

The traditional picture of the nonliving world is colored by the composition of the earth's crust with its predominance of siliceous rocks. A comparison of the relative abundances of the elements in the earth's crust and the cosmic abundances (Table 1) reveals that the earth's crust is not a fair sample of total matter. In fact, carbon, nitrogen, and oxygen make up about three-fourths of the total matter of the universe, apart from hydrogen and helium. The formation of the earth therefore involved a fractionation which left it relatively impoverished with respect to the lighter elements which make up organic compounds (*3, 4*), and the richness of organic complexity on our own planet was formed out of the mere dregs of cosmic distillation. However, the data on cosmic abundance are based mainly on the atomic spectra of the stars, and we have only the most rudimentary information on the *molecular* chemistry of the universe (*5*).

The overabundance of H suggests that the most prevalent molecules will be more or less saturated hydrides of carbon, nitrogen, and oxygen (CH, OH, CH_4, H_2O, NH_3, . . .). Many proposals for the prebiotic appearance of complex organic molecules are based on the photoactivation of these simple precursors by ultraviolet light (*6, 7*). Furthermore, since the elements must have been formed initially at very high temperatures (*8*), they are already "activated" by their incidence as free atoms in space.

Indeed, the bulk of cosmic matter is still dispersed among the stars and galaxies as atoms and molecules and larger particles which are condensates of these, which constitute the cosmic dust. The details of these condensing processes are still most obscure. As summarized by Dufay (*9*): "Although the densities of the CH and CH^+ molecules formed by atomic and molecular reactions are very small, they are perhaps large enough to initiate the condensation. If this point is granted, it would then be necessary to examine the capture of a second atom of hydrogen or of carbon by the CH molecule. Because of the abundance of hydrogen, the first is more probable but the calculation of the probability of formation of the CH_2 molecule is very difficult. It is possible that some more hydrogen atoms attach themselves to the CH_2 molecule (CH_2 CH_3 CH_4 ?) but before long it is mainly atoms of much larger mass (C, N, O, . . .) which are captured because the large molecule formed is not sufficiently cold to prevent the evaporation of hydrogen. Thus, little by little, due to a mechanism which is difficult to evaluate in detail, minute grains which seem to serve as centers of condensation are built up." The scattering of light from distant stars indicates that the grains may grow to sizes of a few tenths of a micron. Furthermore, the observed polarization of the light from distant stars following its passage through galactic clouds speaks for the asymmetric shape of the grains and their orientation presumably by magnetic fields (*9, 10*).

The grains, being condensed from a pool of reactive free atoms among which hydrogen predominates, might be ices (crystals) of the simple hydrides— CH_4, NH_3, and H_2O—or more complex molecules containing the same elements. Which composition predominates will depend on the extent of discrimination against H which was quoted in the previous paragraph. One basis for further speculation is the occurrence of spectral lines identifiable with nonhydride molecules such as C_2, CN, and CO in the emission from comets and in the interstellar absorption (*5, 10*). The possibility of extensive macromolecular organic synthesis by this mechanism is a new point of convergence of biochemical and astro-

Professor Lederberg is chairman of the Department of Medical Genetics, University of Wisconsin, Madison; Dean B. Cowie is a member of the staff of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, Washington, D.C. This paper was delivered at a symposium on "Possible Uses of Earth Satellites in Life Science Experiments," in Washington, 14–17 May, under the sponsorship of the National Academy of Sciences, the American Institute of Biological Sciences, and the National Science Foundation.

physical research. The problem is extremely complex both in theory and in the construction of laboratory models; many factors, such as local fluctuations in atomic abundance, radiation flux and polarization, magnetic orientation, temperature, and the catalytic role of nuclei of condensation, all have to be taken into account.

In favorable circumstances the chemical evolution of the growing grain will be determined in the first place by the random sequence of atomic collisions. The accretion of a colliding atom will depend in part on its kinetic energy and on its composition and that of the incipient grain. The composition of the grain between impacts will also determine its stability—that is, its temperature in the radiation field, in accord with its absorption spectrum. Thus, despite the random input of precursor atoms, the evolution of the grain will also be determined by a sort of natural selection, those agglomerates that are maladapted being vaporized, and the constituent atoms will be returned to the precusor pool. The grains rarely grow larger than 0.5 micron in diameter, perhaps due in part to evaporative collisions of such large grains with one another (*9*).

A serious difficulty in the theory of interstellar grains has been the inefficiency of diatomic reactions in free space without the participation of preformed grains to serve as nuclei of condensation (*11*). It would seem to be necessary to invoke either an independent source of nucleation in the emanation from sooty "carbon stars," as Hoyle has suggested (*12*) or a mechanism of fission of spontaneously formed nuclei so that these may increase in number as well as accrete in mass. The fission of grains might occur either by internal exergonic rearrangement, by photochemical dissociation, or by splitting from colliding atoms. The potentiality for fission is therefore another element in the chemical evolution of the grains.

Apart from the scope of its own evolutionary development, the system of organic synthesis in space is important to the origin of life in two respects: as a model of some of the reactions accompanying the formation of the planet and as a continual source of replenishment of organic precursors for life. From another viewpoint, Hoyle (*12*) has invoked the possibility of a large budget of organic material in the initial condensation of the earth. This budget would be replenished by photochemical reactions in the atmosphere and by the accretion of cosmic dust by meteoric infall. The importance of the initial budget depends on the outcome of controversial questions about the temperature of the earth during its early history (*3*, *4*).

Table 1. Relative abundance of the elements (expressed in atomic abundances). Scale: Elements other than H and He total 1.)

Element	Relative abundance		
	Cosmos*	Terrestrial atmosphere† and hydrosphere†	Earth's crust‡
H	1600	2	0.03
He	160		
O	0.378	0.978	0.623
N	0.269	0.003	
Ne	0.168 ±		
C	0.135	0.0001	0.0005
Si	0.017		0.211
Mg	0.015		0.018
Fe	0.012		0.019
S	0.003	0.0005	
Ca	0.002		0.019
A	0.002		
Al	0.002		0.064
Na	0.001	0.008	0.026
Ni	0.0005		
Others	0.002	0.011	0.020

* After Urey (*3*).
† After Hutchinson, in *The Earth as a Planet* (*4*).
‡ After Mason, in *The Earth as a Planet* (*4*).

Interstellar and Interplanetary Dust

Efforts to make detailed evaluations of the composition of cosmic matter are hindered by the discrepancies between interstellar and interplanetary dust, since the latter must reflect in part the fractionation of the elements in the formation of the solar system and also the local intensity of the gravitational and radiation fields of the sun. The interplanetary dust will include solar emanations, interstellar matter swept out by the proper motion of the sun, and (possibly most abundant) the debris of asteroids and comets. The former, comprising most of the meteorites, will have a stone and iron composition like that of the earth; the cometary debris, which, according to Whipple (*13*), is mainly responsible for visual meteors and for micrometeorites, is of special interest in the present context. Being formed at great distances from the sun, the comets most nearly, among all the interplanetary objects, represent the composition of interstellar matter.

The density, sources, and composition of the interplanetary material represent some of the most challenging objectives of satellite research. Published estimates of the rate of infall of this material vary widely and have dealt almost exclusively with nonvolatile constituents which can be observed in meteorites. Some of the higher estimates can be extrapolated so as to suggest that infall during geological history might have made a significant contribution to the composition of the earth's surface. For example, Petterson (*14*) has estimated an infall of 3.5×10^{11} g of Ni per year. If this is multiplied by the cosmic C:Ni ratio (Table 1), we obtain for C alone 10^{14} g per year, or 10^{23} g for a billion-year interval of geological history. This figure may be compared with an annual photosynthetic turnover of 10^{17}g; a biosphere of 10^{18} to 10^{19} g; 10^{20} g of C available to the biosphere in the atmosphere and oceans; and 10^{23} g of fossil C, including that trapped in the sedimentary rocks (*4*). The extrapolated estimate is almost certainly exaggerated. However, a precise knowledge of infall is certainly necessary in order to evaluate its contribution to geochemical evolution, on our concept of which the analysis of biochemical evolution must be based.

Terrestrial observations of infall are of limited value with respect to the quantity and quality of interplanetary carbon, since whatever organic matter fails to be oxidized while falling through the atmosphere is likely to be degraded by or confused with the existing biosphere. Some exceptional opportunities invite more detailed analysis by modern methods; for example, the "Cold Bokeveld" meteorite is reported to contain appreciable amounts of organic acids, as well as organic compounds containing S, N, and Cl which have not been explicitly identified (*15*). Barring such exceptional finds we must look to the moon for samples of undegraded and uncontaminated dust with which to check these speculations. Owing to the loss of smaller (lighter) molecules from the weak gravitational field of the moon, our assessment of this fraction should be bolstered by whatever samples can be filtered from interplanetary space.

Panspermia

The earth and perhaps other planets might serve as sources for the cosmic dissemination of life. Because the hypothesis of panspermia does not solve the basic

problem of the origin of life, but merely transfers it to another site, it has been discounted by most commentators. However, gene flow among the planets would alter the diversification of evolutionary patterns, and the transport of even a fragment of an organism might short-circuit an otherwise tortuous history of evolutionary progress. It should be conceded that planetary biology will have greater fundamental interest if it does reflect wholly independent origins of life so as to furnish an opportunity for comparative study of wholly different biochemical systems. On this basis, the most interesting questions will not be the expected convergent evolution of extraterrestrial organisms towards superficial resemblances in parallel habitats, but the details of their biochemical make-up. As far as we know, all terrestrial organisms have their genetic basis in nucleic acids. If, say, the Martian flora likewise proves to contain deoxyribonucleic acids, we will face a difficult problem: Have these compounds evolved recurrently as a unique solution to the requirements of genetic replication, or do we share a common ancestor? The dilemma is no less pointed if we find another genetic material: Is it an independent solution or an evolutionary divergence conditioned by a unique habitat? Thus, a definitive conclusion on Arrhenius' hypothesis will be an indispensable element of cosmic biology.

The problem of expulsion of particles no smaller than He^3 from the gravitational field of a planet like the earth by natural agencies already poses formidable difficulties for the hypothesis of panspermia. These are compounded by the radiation hazards of extra-atmospheric space (*6*), although we need more information on the potency of these hazards under the actual conditions of space. To defend Arrhenius' thesis on the basis of present information is difficult, but the thesis is too important to be rejected by prior reasoning short of an empirical test.

In fact, we can point to one mechanism which meets the requirements of ejection and safe transport from the earth: the interplanetary missile. Unless specific precautions are taken, such space craft are likely to carry terrestrial organisms to the moon or other targets. Such contaminants might make an explicit test of Arrhenius' hypothesis difficult to interpret. The surface area of the moon is 4×10^{13} m^2. Microbial populations can easily reach 10^{13} microorganisms per kilogram of contaminated material.

The same considerations apply even more strongly to other destinations. Artificial contamination might distort the microbiology of more hospitable planets and might even perform the function posited by Arrhenius of seeding a previously sterile planet.

A given level of contamination, be it biological or chemical, is significant in relation to the sensitivity of currently available methods of analysis. Advances in analytical chemistry are likely to make meaningful levels of occurrence or contamination which are beyond the scope of present techniques. Present methods are already sensitive enough that radiochemical analysis of, say, the moon's surface might be perturbed by the fallout from a single atomic missile.

Since the sending of rockets to crash on the moon's surface is within the grasp of present technique, while the retrieval of samples is not, we are in the awkward situation of being able to spoil certain possibilities for scientific investigation for a considerable interval before we can constructively realize them. However, our assessment of the validity of these risks may become more reliable with the accumulation of information on the physical parameters of extra-atmospheric space and with the astrophysical data that can be collected to great advantage from artificial satellites. There are, in addition, many model experiments in microbiology and biochemistry that can be performed in the terrestrial laboratory, and some information on the survival of spores might be collected from telemetered experiments in satellite devices.

At the present pace of missile development we urgently need to give some thought to the conservative measures needed to protect future scientific objectives on the moon and the planets. We are pleased to note that at the instance of the National Academy of Sciences of the United States, the International Council of Scientific Unions has established a special committee under the chairmanship of M. Florkin of Liège, Belgium, to review the problems of contamination of extraterrestrial objects.

References and Notes

1. D. H. Menzel, *Natl. Geographic Mag.* 113, 277 (1958).
2. S. Arrhenius, *Worlds in the Making* (Harper, New York, 1908).
3. H. C. Urey, *The Planets: Their Origin and Development* (Yale Univ. Press, New Haven, Conn., 1952).
4. G. P. Kuiper, Ed., *The Earth as a Planet* (Univ. of Chicago Press, Chicago, 1954).
5. "Les particules solides dans les astres," *Colloq. intern. d'astrophys. No. 6*; "Les molécules dans les astres," *Colloq. intern. d'astrophys. No. 7* (Inst. d'Astrophys. Univ. de Liège, Cointe-Sclessin, Belgium, 1954; 1956).
6. A. I. Oparin, *The Origin of Life on the Earth* (Academic Press, New York, ed. 3, 1957).
7. S. Miller, in *Reports on the International Symposium: The Origin of Life on the Earth* (Akad. Nauk. S.S.S.R., Moscow, 1957), pp. 73–85.
8. E. M. Burbidge *et al.*, *Revs. Modern Phys.* 29, 547 (1957).
9. J. Dufay, *Galactic Nebulae and Interstellar Matter* (Philosophical Library, New York, 1957).
10. J. A. Hynek, Ed., *Astrophysics, a Topical Symposium* (McGraw-Hill, New York, 1951).
11. D. R. Bates and L. Spitzer, *Astrophys. J.* 113, 441 (1951).
12. F. Hoyle, *Frontiers of Astronomy* (Mentor, New York, 1957).
13. F. L. Whipple, *Astrophys. J.* 113, 464 (1951).
14. H. Petterson, *Nature* 181, 330 (1958).
15. G. Nueller, *Geochim et Cosmochim. Acta* 4, 1 (1953).

U.S. Geological Survey Radiocarbon Dates IV

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The following list (Table 1) covers radiocarbon dates measured at the U.S. Geological Survey radiocarbon laboratory during the period between 1 July 1955 and 7 November 1956 (*1*). The laboratory procedure, in which acetylene gas is used, has remained essentially the same (*2*), and the ages and errors have been computed in the same manner as before (*3–5*). The additional step of boiling wood, charcoal, and peat samples in NaOH as well as in HCl has been included in the pretreatment of samples to remove lignins and humic acid fractions. This was done to eliminate the possibility of foreign carbon addition in the form of stains or accumulations by ground water solutions. This pretreatment does not reduce the danger of rootlet contamination, however. Most of the 180 samples have been measured in two counting sets for a total of 3 days each.

Some of the problems pursued in this series of dates include: (i) the age of sea water, which is of considerable geochemical importance in the formulation of atmosphere–mixed layer–deep-sea equilibrium models (*6*); (ii) the age of the Mankato substage, which proved to be a pre-Two Creeks rather than a post-Two Creeks event (*7*); (iii) the sequence and timing of the continental glaciations on the North American continent and its contemporaniety with those in South America and Australia; (iv) climatically induced sea-level changes as related to the postglacial altithermal interval; (v) the dating of mountain glaciations; (vi) the timing of pluvial stages of lakes in the Interior Basin (*8*); (vii) Alaskan glacial chronology; and (viii) the study of modern grass for evidence of nuclear bomb contamination of the atmosphere.

Units of measurements listed in the descriptions of samples are those expressed by the collectors.

Table 1. Radiocarbon dates.

Description	Sample No.	Age (yr)
I. *Samples with oceanic implications*		
Sea-water carbonate. Large samples of sea water from known depths in the Atlantic Ocean were processed on shipboard with acid to drive off the CO_2. The gas was collected as a carbonate and submitted to the U.S. Geological Survey by G. Jaffe and F. Gaetano of the U.S. Navy Hydrographic Office. Precise measurements in two counters were made to determine the C^{14} activity of the carbonates. In addition, a portion of each sample converted to acetylene was submitted to H. C. Urey's laboratory at the University of Chicago, where C^{13}/C^{12} analyses were made by T. Mayeda. A C^{13} correction was made on each carbonate sample to normalize the readings to the δC^{13} of -25.00 per mil which H. Craig finds as the average for woods (*9*). The corrected activity was then compared with that of a 19th century wood, corrected for C^{13} and age. The results are arbitrarily presented in the form of years of age, rather than activity deficiency.		
Surface; lat. 15°22′N, long. 60°23′W.	W-313	650 ± 60
Depth 640 m; lat. 16°04′N, long. 57°31′W.	W-351	635 ± 60
Depth 1620 m; lat. 16°10′N, long. 56°26′W.	W-352	630 ± 60
Depth 1750 m; lat. 16°42′N, long. 57°13′W.	W-314	840 ± 60
Bahama Banks, Bahama Islands. A series of core samples taken in traverses off the western side of Andros Island in the Bahamas from a sequence consisting of unconsolidated calcareous sediments overlying a rock platform of limestone as part of a study made by the collector, P. E. Cloud (U.S. Geological Survey), to determine time of deposition or subaerial alteration of these rocks.		
Top of core of calcareous sediment from collector's locality G3, 6 to 12 in. below the water-sediment interface.	W-448	450 ± 200
Bottom sample of sediment at locality G3, 78 to 84 in. below the interface, directly above rock platform.	W-447	2490 ± 400
Core from upper surface of rock platform beneath calcareous sediments, collector's locality D1.	W-327	16,955 ± 400
Same as above, from B1.	W-383	21,300 ± 1000
Same as above, from D5.	W-384	19,300 ± 1000
Same as above, from C2.	W-446	17,000 ± 800
Same as above, from F2.	W-449	12,400 ± 600
Same as above, from A11.	W-450	15,600 ± 800
Same as above, from E9.	W-451	15,440 ± 800
Same as above, from C6.	W-452	16,730 ± 850
Same from 1.5- to 2-ft bluff of punky compact limemud, at western apex of Andros Island, locality C7a.	W-330	1675 ± 200
Rerun of W-330, different specimen.	W-453	1025 ± 400
Wells, Me. Samples from a large tidal marsh at Wells, near the mouth of Upper Landing Creek, near Eton farm. The marsh is sheltered from the ocean by a long barrier beach, never overtopped even during the largest storms today. The collector, W. H. Bradley (U.S. Geological Survey, Washington, D.C.), believes that this barrier beach was probably formed during the climatic optimum when sea level may have been 5 or 6 feet higher than it is now.		
Mya shells buried in mud in a layer 1 ft above the mean-low-tide line, found in upright, living position 1100 ft from land.	W-395	200 ± 160
Tree stump in place, 2 ft below mean high tide and 300 ft from land. The tree grew at a stage when sea level was lower	W-396	2980 ± 180

Description	Sample No.	Age (yr)
than it is today—sometime during the post-climatic optimum, perhaps during Matthes' Little Ice Age.		
Sagadahoc Bay, Me. Mya shells from two buried, extensive, thin, but highly characteristic *Mya* shell pavements in the Sagadahoc Bay tidal flats. Collected by W. H. Bradley for an investigation of the history of the tidal flat.		
Mya shells from 2 ft below present surface.	W-328	390 ± 160
Mya and *Gemma* shells from 11 to 13 in. depth.	W-329	< 200
Neskowin, Ore. Fragments of Sitka spruce collected from several stumps, situated below mean tide in the Pacific Ocean, 50 to 200 ft south of Proposal Rock. These stumps are exposed only at very low or minus tides, the seawardmost stump being at the 0.0-ft tide mark. The stumps are part of a drowned forest, from an area believed not to be affected by local subsidence; the drowning is therefore considered to have been a result of eustatic rise in sea level. Collected by P. D. Snavely, Jr., U.S. Geological Survey, Menlo Park, Calif.	W-390	1730 ± 160
Guam, Mariana Islands. Tridacna shell from the north side of Facpi Point, Guam, found imbedded in emerged constructional reef limestone, the upper flat surface of which is 3 to 4 ft above low-tide level. The reef in which the shell was found must have grown during a sea stand higher than present sea level, possibly during the "6-foot stand." Collected and interpreted by S. O. Schlanger, U.S. Geological Survey, Washington, D.C.	W-370	3400 ± 250
Peel Island, Australia. Coral, *Mycedium tubifex,* collected 1939 by an expedition of the Great Barrier Reef Committee, from Dead Reef, Western Spit, Peel Island, Moreton Bay, Queensland. Submitted by E. D. Gill, National Museum of Victoria, Melbourne, for dating the 10-ft stand of the ocean. Gill states: "Measurements of strand lines made on the adjacent island of St. Helena indicate that the dead reefs are due to a recent lowering of sea level of between 10 and 12 ft."	W-443	3710 ± 250
II. *Glacial samples*		
Athol, Mass. Log from near the base of swamp material on top of outwash in a swamp 3800 ft west of Pleasant Street, 1350 ft south of a curve in Bachelder Road in the west-central 1/9 of Athol quadrangle, Mass. The log gives a minimum date for the last glacial substage in Massachusetts. Collected by Margaret Bryan, U.S. Geological Survey, Denver, Colo.	W-361	10,800 ± 250
Corry, Pa. Peat and marl from a bog in a kettle hole just inside the city limits of Corry, Erie County. This locality is 6 mi within the outer Wisconsin drift margin, which is near Binghamton. The section consists of (from surface down) 9.7 ft of peat, 3 ft of marl and base in clay. Sample from J. B. Droste, R. W. Doehler, and G. W. White (University of Illinois).		
Peat from basal 8 in. of peat.	W-347	9430 ± 300
Marl from top 8 in. of marl.	W-346	13,000 ± 300
Marl from basal 8 in. of marl.	W-365	14,000 ± 350
Westchester, Ohio. Wood found in area of the early Wisconsin terminal moraine exposed in one of the branches of the East Fork of Mill Creek, about ⅓ mi east of Westchester, Mason quadrangle. Collected by J. L. Rich, University of Cincinnati.	W-304	20,500 ± 800
Anderson, Ohio. Log from contact of blue-gray till overlying sand and medium coarse gravel exposed in cut along east bank of Anderson Run, at Anderson, Ross County, in Wisconsin terminal moraine. Till thickness, 0 to 15 ft; sand, 5 to 15 ft. Collected by R. P. Goldthwait, Ohio State University.	W-331	18,000 ± 400
Sidney, Ohio. Log from between two tills exposed near Sidney, Shelby County, at the Baltimore & Ohio Railroad cut ¾ mi west of U.S. highway 25. The log came from the base of surface till and immediately above soil developed on underlying till (*10, 11*). (Same locality and position as sample W-188, which was dated 23,000 ± 800 yr.) Collected by J. L. Forsyth, R. P. Goldthwait, and M. Rubin.	W-356	22,480 ± 800
Kirkwood, Ohio. Samples taken from a cut along Upper Brush Creek, ½ mi east of U.S. highway 25, in NW¼NW¼ sec. 6, Shelby County (*10*). From base, the section consists of calcareous till, 1 ft exposed; leached gravel, 0 to 3 ft; soil, clay, and sand, 2 to 3 ft; peat band with twigs, 0 to ½ ft; calcareous till, with logs near base, 2 to 25 ft; gravel, alluvial, 0 to 4½ ft; soil, 2 ft. Collected by J. L. Forsyth, Geological Survey, Ohio Department of Natural Resources, Columbus.		
Log taken from near base of upper till.	W-414	22,000 ± 1000
Twigs from peat band below till.	W-415	> 37,000
Parkerstown, Ohio. Wood from a peaty zone below Lake Whittlesey beach gravels at the intersection of the Ohio Turnpike and Ohio route 4 in Erie County. Underlying the peat is sandy alluvium and lake clay and at the base, calcareous till (*10*). Collected by J. L. Forsyth.	W-430	12,920 ± 400
Muncie, Ind. Wood from Buck Creek ditch, SE¼SW¼ sec. 14, T19N, R10E, 7 mi south of Muncie, Delaware County. This fossiliferous bed is exposed from near Muncie to near Newcastle in the banks of Buck Creek and Blue River and has yielded remains of deer, elk, and mastodon (*12*). Collected by J. Frye, B. Leonard, W. J. Wayne, and M. Rubin.	W-325	9755 ± 300
Granite City, Ill. Wood from a dug Ranney collector well at Granite City, 1300 ft east, 2250 ft south of the northwest corner, sec. 20, T3N, R9W, Madison County. Wood was taken from a depth of 60 to 65 ft in what was thought to be Recent alluvium. Sample and stratigraphic interpretation made by R. E. Bergstrom; submitted by M. M. Leighton, Illinois State Geological Survey, Urbana.	W-317	8340 ± 250
Princeton, Ill. Peat and wood from a section exposed in the west valley wall of East Bureau Creek, 4.5 mi east of Princeton, SE¼NW¼ sec. 8, T16N, R10E, Bureau County. The section includes, in ascending order, (i) Illinoian till with Sangamon profile of weathering, 11 ft exposed; (ii) Farmdale loess, 3 ft; (iii) Iowan loess, 9 ft; (iv) pro-Tazewell, coarse gravel outwash, 10 ft; (v) Taze-		

Description	Sample No.	Age (yr)
well till, 20 ft; (vi) Tazewell loess, 4 ft. Samples and stratigraphy by M. M. Leighton.		
Wood from black soil 2 ft below top of Farmdale loess.	W-333	25,700 ± 800
Peat from peat layer 15 in. below contact of peaty Iowan loess with pro-Tazewell gravel. Records continued growth and accumulation of plant remains during a brief pause in loess deposition.	W-334	22,450 ± 1000
Farm Creek, Ill. Wood from classic Farm Creek section, 6 mi east of Peoria, SW¼ SE¼ sec. 30, T26N, R3W, Tazewell County. The Iowan here is directly overlain by tight stony till of Shelbyville age. Samples and stratigraphy by M. M. Leighton.		
Wood from upper 3 in. of Iowan loess.	W-349	20,340 ± 750
Wood from upper 6 in. of Iowan loess. Glacial erosion here seems to have been negligible, but cannot be demonstrated.	W-399	20,700 ± 650
Bloomington, Ill. Samples from section exposed in the south bank of Rock Creek, 15 mi northwest of Bloomington, NE¼ NW¼ sec. 32, T25N, R1W, McLean County. This section was described by the late Leland Horberg (*13*) and consists of, in ascending order, (i) Illinoian till, (ii) Farmdale loess; (iii) Iowan loess; (iv) Tazewell till. Samples and interpretation by M. M. Leighton.		
Moss peat from contact of Iowan loess and overlying Tazewell (probably Shelbyville) till. The presence of the moss peat was discovered by J. Brophy, and the moss was later identified by W. Welch as species of *Calliergonella* and *Drepanocladus*.	W-379	24,700 ± 1000
The age of the moss seemed to be excessive, and a new sample from the identical horizon was collected and run.	W-483	20,500 ± 600
Fossil wood from 10-in. peaty layer 3 ft below the top of Farmdale loess.	W-406	26,150 ± 700
Havana, Ill. Wood from 15 ft below the top of a terrace of Bloomington outwash and backwater deposits, exposed in a ravine 5 mi west of Havana, NE¼ sec. 33, T4N, R3E, Fulton County. These sediments were deposited during aggradation of Illinois Valley (to which the ravine is tributary) by Bloomington valley-train materials. Middle Tazewell. Stratigraphy by H. R. Wanless; sample collected by Wanless and M. M. Leighton.	W-381	15,600 ± 600
Chicago, Ill. Wood from sediments of Lake Chicago taken from the North Shore Channel by F. C. Baker during 1910–1914. Submitted by M. M. Leighton from Baker's Illinois State Geological Survey Pleistocene fossil collection (*14*).		
Wood from silt, stratum VII, station 9, 1402 ft north of Foster Ave. on North Shore Channel.	W-425	5370 ± 200
Wood from sand, stratum XI, station 33, 500 ft south of Devon Ave. on North Shore Channel.	W-426	10,700 ± 300
Bonfils, Mo. Wood from gray calcareous silt in a terrace exposed in a quarry 0.5 mi south of Bonfils. Collected by M. M. Leighton and R. E. Bergstrom.		
Wood from 14 ft below top of terrace.	W-469	17,150 ± 600
Wood from 16 ft below top of terrace.	W-470	17,800 ± 600
Traverse City, Mich. Wood from near Brookside subdivision, at Stop No. 1 of the Mid-West Friends of the Pleistocene trip, 1956. Samples came from 6 ft down	W-467	< 200

Description	Sample No.	Age (yr)
in the first layer of the Valders till of Thwaites. Discussion ensued as to whether the wood was from modern trees or whether it dated the Valders. Collected by M. Rubin.		
Mankato, Minn. Wood from within a gray till underlying the surface buff till exposed in a cut along the relocation of highway 169, 4 mi north of Mankato on the west valley wall of the Minnesota River, Nicollet County. Lower till is unleached. Collected by J. H. Zumberge, University of Michigan.	W-300 W-301	> 37,000 > 37,000
North Branch, Minn. Wood and peat buried beneath 5 ft of sand of Anoka sand plain, from a drainage ditch 3 mi southeast of the town of North Branch, Chisago Country; formed during the wastage of the Grantsburg sublobe of the Des Moines lobe (7). Collected by H. E. Wright, Jr., University of Minnesota.		
Wood from 6-inch peat layer.	W-354	12,030 ± 200
Peat from same horizon as sample W-354.	W-389	12,700 ± 250
Moorhead, Minn. Wood from Moorhead Station 2, Clay County. Peat from a depth of 45 ft in lake clay. Rerun of Chicago's C-497 (11,283 ± 700 yr). Procured from W. F. Libby's laboratory through E. A. Martell.	W-388	9930 ± 280
Minneapolis, Minn. Wood and peat incorporated in sand of Mississippi Valley train from building excavation in Loring Park. Collected in 1923 by W. S. Cooper (*15*) from a depth of 3 to 12 ft; submitted by H. E. Wright, Jr.		
Peat from sand.	W-445	10,200 ± 300
Wood from same sand.	W-454	11,790 ± 200
Blomford, Minn. Basal organic sediment from a lake on Grantsburg till near Blomford, Isanti County, at a depth of 12 ft below the water surface. Collected by H. E. Wright, Jr.	W-465	4890 ± 200
Cedar Creek Bog Lake, Minn. Gyttja from an ice-block feature in the Anoka sand plain in south-central Isanti County, from the base of the organic sediment at a depth of 30 ft just above the sand. Collected by H. E. Wright, Jr., and F. M. Swain, University of Minnesota.	W-466	11,830 ± 200
Kittson County, Minn. Peat from rotary test hole SW¼SE¼ sec. 30, T161N, R46W, at depth of 95 ft in Lake Agassiz sediments. In a test hole 1.7 mi southeast of the sampled one, in a "shoreward" direction, Lake Agassiz deposits extend to 120 ft. Collected by J. R. Rapp and R. Schneider, U.S. Geological Survey, St. Paul, Minn.	W-468	> 36,000
Anoka, Minn. Peat from depth of 3 ft in sand in a low terrace of Rum River on the Anoka sand plain, 3 mi northeast of Anoka in center sec. 27, T31N, R24W, Anoka County. Collected by R. Farnham, H. E. Wright, Jr., and M. Rubin.	W-497	1900 ± 250
Knife River, N.D. Marl with gastropods from a local lens in late Wisconsin till (Mankato?), in NE¼SE¼ sec. 30, T146N, R89W in road cut, west side of section line road, south side of small draw. Collected by W. E. Benson, National Science Foundation, Washington, D.C.	W-402	11,220 ± 300
Jackson Hole, Wyo. Carbonized fragments in varved glacial silt which overlies 150 ft of outwash in an exposure 500	W-312	27,000 ± 800

Description	Sample No.	Age (yr)
ft above the broad valley of Pilgrim Creek, in NE¼N¼ sec. 29, T46N, R114W. The silt is believed by the collector to be somewhat younger than the Buffalo glacial stage (*16*). Collector, J. D. Love, U.S. Geological Survey, Laramie, Wyo.		
Grand Teton National Park, Wyo. Shell material from a white marl associated with and possibly slightly older than knob and kettle topography and outwash gravels of the Pinedale glacial substage, 3 mi southeast of Jackson Lake, in sec. 32, T45N, R114W, Teton County (*16*). Collected by J. D. Love and D. Taylor, U.S. Geological Survey, Laramie, Wyo.		
Shells underlying thick gravel bed.	W-392	9580 ± 250
Shells at depth of 3 ft, 3/16 mi northwest of sample W-392.	W-393	8800 ± 250
Port Angeles, Wash. Wood taken from exposure along U.S. highway 101, northeast of bridge across Morse Creek, 2 mi east of Port Angeles. Twigs, limbs, and logs occur in bedded sandy clay in glacial or glaciofluvial deposits which underlie, uncomformably, continental drift of Vashon age. Collected by R .D. Brown, Jr., U.S. Geological Survey.	W-339	> 38,000
Port Angeles, Wash. Wood from a quarry on the east side of a new road, 1050 ft S7°W from BM 6 ft on Port Angeles and Western switching yards at southwest end of Ediz Hook, Port Angeles. Sample is from continental drift of Vashon age and was collected from an outwash. Collected by P. D. Snavely, Jr.	W-391	> 38,000
Puget Sound Basin, Wash. Basal 3 in. of peat overlying Vashon drift at the bottom of peat bogs. Samples were selected to determine minimum age for the Vashon as well as the rate of retreat. Collected by D. R. Crandell, H. H. Waldron, and D. R. Mullineaux, U.S. Geological Survey, Denver, Colo.		
Belmore, at depth of 35.5 ft, SW¼ sec. 34, T18N, R2W, about 2 mi southwest of Olympia.	W-394	11,500 ± 300
Thomas Lake, 16.2 ft, SW¼ sec. 33, T28N, R5E, about 7 mi south of Everett.	W-397	9230 ± 320
Sedro Woolley, 27.2 ft. SW¼ sec. 31, T36N, R5E, about 3 mi north of Sedro Woolley.	W-398	12,900 ± 330
Fairbanks, Alaska. Wood from stump in place, from Fairbanks Creek, opposite valley from FE Mining Camp, 20 mi northeast of Fairbanks. The stump was from near the base of Engineer formation, overlying the Goldstream muck. Collected by T. L. Péwé, U.S. Geological Survey, College, Alaska.	W-434	6040 ± 240
Fairbanks, Alaska. Fragments of stems and twigs from 8 ft below the unconformity separating Goldstream muck from the overlying Engineer formation, at Eva Creek, 9 mi west of Fairbanks in sec. 5, T1S, R2W. Collected by T. L. Péwé.	W-435	23,900 ± 1000
Sheep Creek, Alaska. Log and twigs from the east wall of a placer cut on Sheep Creek, SE¼ sec. 17, T1N, R2W. Collected by T. L. Péwé.		
Log at unconformity between what is thought to be post-Wisconsin loess and Wisconsin frozen organic silt, 4 ft below surface.	W-475	> 35,000
Twigs from a woody horizon 5 ft below unconformity in Wisconsin muck associated with large foliated ice masses.	W-476	> 35,000
Galena, Alaska. Log from 10 ft below surface at base of muck formation overlying clean brown sand exposed in cut bank of Yukon River (north bank), 6 mi upstream from Galena. Collected by T. L. Péwé.	W-472	8140 ± 300
Cook Inlet region, south-central Alaska. Peat from organic lacustrine section exposed at top of 80-ft-high sea bluff immediately south of East Foreland, Kenai Peninsula. The sample was collected from the base of a 3- to 5-ft thick section of folded peat and organic silt, silt and sand unconformably overlying intensely folded sand and gravel, and overlain unconformably by 6 to 12 ft of slightly folded sand and organic silt and by 8 ft of undisturbed organic lake silt. The pattern of folding and the lithologic character of these sediments, which border end moraines of Naptowne and Knik age, are interpreted as indicating a series of ice advances near East Foreland of a piedmont glacier lobe which advanced across the inlet from the Alaska Range. (See description of sample W-294, which was collected from an older series of related deposits.) Insofar as the Naptowne end morainal deposits are involved in the folding, it is evident that the most recent of the recorded intervals of advance deformation is post-Naptowne maximum in age. The age (12,950 yr) of the sampled horizon, because it marks an interval just prior to a late episode of advance, is consistent with this interpretation and with the placement of the culmination of the Killey (Cary)-Skilak (Mankato) interstadial boundary (12,500 yr) as earlier derived (*17*). Collected in 1954 and interpreted by T. N. V. Karlstrom, U.S. Geological Survey, Washington, D.C.	W-416	12,900 ± 300
Cook Inlet region, south-central Alaska. Organic silt from a bog deposit buried beneath eolian sand exposed in sea bluff near Point Possession, Kenai Peninsula. The sample was collected from near the base of an organic silt section overlying about 20 ft of glaciolacustrine stoney silt of Naptowne (Wisconsin) age and about 30 ft of pre-Naptowne drift, deeply oxidized and contorted. This sample provides a minimum date for the drainage of the proglacial lake or at least of the lowering of the lake surface well below an elevation of about 150 ft above present sea level in the upper part of Cook Inlet. Slight oxidation at the top of the glaciolacustrine deposits suggests a brief interval of subaerial weathering between the termination of proglacial lake deposition and the beginning of organic silt accumulation in a depression of the newly exposed lake bottom. The sample is consistent in age and stratigraphic position with sample L-137C (9500 ± 650 yr), which was collected from the same section and from a stratigraphically higher woody peat horizon which records a major interval of bog drying essentially contemporaneous with that of the Skilak (Mankato)-Tanya (Cochrane) interstadial and with the Yoldia sea transgression in Eu-	W-474	10,370 ± 350

Description	Sample No.	Age (yr)
rope (*18*). Collected in 1954 and interpreted by T. N. V. Karlstrom.		
Cook Inlet, Alaska. Sample from a buried forest zone in a till section exposed in a railroad cut near Tunnel Section House on the Alaska Railroad between Seward and Portage, on the Kenai Peninsula. The cut lies within ¾ mi of Bartlett Glacier and between end moraines that mark the maximum advances of the Tunnel I and Tunnel II glacial events of the Cook Inlet glacial chronology (*18*). The stratigraphic sequence, from top to bottom, is as follows: 2 to 6 ft of surface till (Tunnel I) with an incipient soil profile; forest zone (sample W-318); and 6 to 8 ft of till oxidized at top contact to depths of 1 to 5 in. The basal till represents the Tustumena III glaciation of the Cook Inlet chronology. A previously analyzed sample (W-78) collected from an ice-scoured log incorporated in the basal till dated 2370 ± 100 yr. These two samples, plus a third dated sample collected from forest remains buried in Tunnel II till of the innermost belt of the two most recent moraines in front of Tustumena glacier (L-117K, 400 ± 150 yr), support the dating of the Tustumena III glaciation between 500 B.C. and A.D. 500; Tunnel I between A.D. 500 and A.D. 1500; and Tunnel II between A.D. 1500 and the present. Collected and interpreted by T. N. V. Karlstrom.	W-318	1385 ± 200
Central Kobuk River Valley, Alaska. Peaty material collected 95 ft down from the top of a 110-ft bluff on the south side of Kobuk River, west of mouth of Ambler River at lat. 67°05′N, long. 158°10′W. The bluff exposes from top to bottom: 10 ft of tan eolian sand; 65 ft of grayish eolian sand; 35 ft of mixed organic and sandy material. The date serves as a reference point in the chronology of the eolian deposits of the central Kobuk Valley. Collected and interpreted by A. T. Fernald and D. R. Nichols, U.S. Geological Survey, Washington, D.C.	W-420	> 38,000
Upper Kobuk River Valley, Alaska. Log collected 5 ft down from the top of a 20-ft terrace bluff along the east side of Beaver Creek, a tributary of the Kobuk River, at lat. 66°52′N, long. 155°02′W. The bluff exposes 2 ft of peat over 18 ft of rubbly gravel that contains a few logs. Collected by A. T. Fernald and D. R. Nichols.	W-473	2470 ± 250
Central Kobuk River Valley, Alaska. Tree trunk collected 35 ft down from the top of a 100-ft bluff along the north side of the Kobuk River, near the mouth of Kavet Creek at lat. 67°08′N, long. 159°03′W. The bluff exposes from top to bottom: 5 ft of loess; 75 ft of stratified sand, silt, and organic debris; 20 ft of slump material that includes gravel and large boulders. The date is the only available reference point for the chronology of the central Kobuk Valley, which is outside the morainal systems of the Kobuk region. Collected and interpreted by A. T. Fernald and D. R. Nichols.	W-368	> 33,000
Nome, Alaska. The coastal plain at Nome, Alaska, is underlain by a sequence of marine, glacial, alluvial, and colluvial sediments that record a rather complete chronology for at least the latter half of Pleistocene time (*19, 20*). The specimens described here were collected in 1955 in new exposures in the "Submarine Beach" dredging area on the ridge between the lower Snake River and the Bering Sea, 2.5 mi west of Nome. Here, an end moraine of Nome River (presumably Illinoian) age was planed by wave action during a subsequent period of high sea level (presumably Sangamon). The end moraine was truncated at an altitude of 27 ft above sea level, and a gravel barrier bar, known locally as "Second Beach," was built on its surface. Sand accumulated behind the barrier bar in an estuary on the site of the present valley of Snake River. Later, presumably during Wisconsin time, sea level fell, winters became severe though snow cover was thin, and ice wedges formed in the exposed estuarine sand and silt. Late in Wisconsin time, peat and colluvial silt were deposited in a shallow swale on the surface of the estuarine sediments. Shortly afterward, during a period when summers were longer or warmer than at present, the ice wedges began to melt. Colluvial sedimentation continued, filling the trenches resulting from the thawing of the ice wedges. A long hiatus ensued, to be followed a few thousand years ago by renewed deposition of peat and colluvial silt in the swale. Winters became severe again, and a new set of ice wedges formed. The newly dated specimens consist of peat and wood from the colluvial sediments in the swale. They establish the age of the colluvial sediments, give a minimum age for the older ice wedges, a maximum age for the younger ice wedges, and a minimum age for the estuarine sediments of "Second Beach." The period of warm summers, which was apparently initiated here at least as early as between 10,000 and 9500 yr ago, was probably equivalent to a period of warm summers recorded 9500 to 8300 yr ago in northern Seward Peninsula by several specimens analyzed by the solid-carbon method at the Lamont laboratory (*21*). Collected by D. M. Hopkins, U.S. Geological Survey, Menlo Park, Calif.		
Wood from basal colluvial sediments filling a collapse trench on the former site of an ice wedge in the estuarine sediments. Gives minimum age for Second Beach and for the ice wedges subsequently formed in estuarine sediments.	W-463	13,040 ± 300
Peat lens at base of lower colluvial sediments filling another collapse trench.	W-461	10,050 ± 270
Peat from thoroughly involuted colluvial sediments about 2 ft vertically above specimen W-461 and about 2 ft below the top of the unit. Specimens W-461 and W-485 probably bracket the initiation of rapid thawing of ice wedges.	W-485	9690 ± 400
Peat from 1 ft below surface and 0.5 ft above the base of the upper, noninvoluted unit of peat and colluvial silt. Modern ice wedges have tops at about this depth beneath the surface and must be younger than this specimen.	W-484	2770 ± 300
Southeastern Copper River Basin. Peat and wood collected from partially lignitized zone capping 1 ft soil development	W-307	> 37,000

Description	Sample No.	Age (yr)
on silty sand 100 ft down in a 150-ft bluff cut in a terrace of the Copper River, 11 mi southeast of Copper Center. A second buried soil profile lies 3 ft below the sample. The soil horizons, both with distinct podsol developments, overlie 20 ft of greenish grey till and are overlain by 30 ft of sand and fine gravel, 60 ft of coarse outwash gravel, and 10 ft of terrace gravel. The basal 15 ft of the section is concealed. The lignitized peat and wood and soil horizons represent a stabilized surface during an interglacial period which followed deposition of the till. Stratigraphic relations in adjacent bluff sections indicate that terrace cutting at the sample section has removed two tills with thick intervening outwash and lacustrine deposits, which overlie the thick outwash above the sample. The upper till immediately underlies the floor of the southeastern part of the Copper River basin. Collected and interpreted by D. R. Nichols, U.S. Geological Survey, Washington, D.C.		
Southeastern Copper River Basin, Alaska. Twig fragments in coarse pumiceous and andesitic sand in a 300-ft bluff on the north side of the Tonsina River approximately 6 mi above its mouth. The sand is associated with coarse sand and gravel that fill channels cut into an andesite-rich till. The till is presumed to represent a prolonged period of volcanism during a major glaciation. The sand and gravel are overlain by 70 ft of laminated silt and sand with local cobble-gravel zones and by 60 ft of gray surficial till. The andesite-rich till truncates outwash sand and gravel which overlays two older tills. The sample was deposited in outwash during retreat of the ice of a major glaciation and prior to a period of lake deposition and subsequent ice advance. Collected and interpreted by D. R. Nichols.	W-373	> 35,000
Southeastern Copper River Basin, Alaska. Peat and twigs from a 1-in. to 3-ft bed of massive silt and sand exposed in a gravel pit at mile 92, Richardson Highway, 8 mi south of Copper Center. The gravel pit is on the margin of a 15-ft escarpment on the northern boundary of a glacial drainage channel. The organic-bearing sand and silt is overlain by 3 to 4 ft of highly contorted and laminated silt and clay and by 4 to 7 ft of a heterogeneous deposit (till?) with numerous washed zones and lenses of contorted sand and sandy gravel. A soil profile 1 ft thick is developed on the till (?) at the surface. Two to three feet of massive, blocky gray silt with occasional pebbles underlies the sample zone to the base of the exposure. The sequence was interpreted to represent either (i) an ice margin-drainage channel contact during retreat of the last major advance of ice into the basin which dammed the basin drainage and formed an extensive interior lake (*22*), or (ii) possible slumping of the till surface along the drainage escarpment. The date suggests that deposition of the woody material and contortion of some of the bedded deposits is by relatively recent slumping along the escarpment. Collected and interpreted by D. R. Nichols.	W-433	480 ± 160
Barrow, Alaska. Peat from buried organic zone in bottom sediments of an artificially drained lake basin 4 mi south of the Arctic Research Laboratory, Barrow. The sample was collected from an 8-in. bed of silt-free peat overlain by a 2-in. bed of organic-free silt which in turn is overlain by 2-in. of dark brown organic-rich silt. Buried peat in a comparable stratigraphic position is found in several lake basins in this area. Collected by K. M. Hussey and submitted by H. W. Coulter, U.S. Geological Survey, Washington, D.C.	W-432	3540 ± 300
Arctic Coast, Northern Alaska. Log approximately 18 ft long and 6 in. in diameter incorporated in a crossbedded sandy gravel member of the marine Gubic formation of Pleistocene age exposed along the coastal bluffs southwest of Point Barrow, midway between Barrow Village and the Wiley Post Memorial. Extensive marine mega- and microfaunas occur in the Gubic formation. Collected by K. M. Hussey, Arctic Research Laboratory, and H. W. Coulter.	W-380	> 38,000
Upper Matanuska Valley, Alaska. Peat collected from near the top of a 100-ft bluff along the north bank of the upper Matanuska River in south-central Alaska. The site is about 1650 ft above sea level and is 400 ft S20°W of milepost 102 on Glenn Highway, from Anchorage. It is 6000 ft N80°W, or down-valley, from the terminus of Matanuska Glacier, one of the largest in the northern Chugach Mountains, and the chief source of the Matanuska River. Most of the river bluff is formed of coarse, crudely bedded, glacial drift. At the sample locality it is capped by bog and pond deposits consisting of (i) 4 ft of surficial peat which contains three thin beds of volcanic ash and (ii) basal silt containing numerous fresh-water gastropods and pelecypods (U.S. Geological Survey, Cenozoic locality No. 19191). The dated sample was taken from the basal inch of peat, just above its contact with the fossiliferous silt. The sample dates initiation of peat deposition within the pond depression and therefore provides a close approximation of the date of change from pond to bog environment. The undisturbed, horizontal volanic ash beds and the fresh, uncompressed character of the peat, together with the absence of a mantle of glacial drift, show that the Matanuska Glacier has not covered the site since deposition of the dated peat. The date, therefore, provides a minimum age for the last time during which the site, only 6000 ft from the present terminus, was covered by the Matanuska Glacier. Collected by J. R. Williams and O. J. Ferrians, Jr., U.S. Geological Survey, Washington, D.C.	W-431	8000 ± 300
Northeastern Copper River Basin, Alaska. Peat collected from road cut at approximately mile 61.3, Tok Highway, just east of Ahtell Creek. The section from the base (road level) upward consists of 6 ft of well-oxidized, well-sorted, coarse gravel; a 1-ft lens of unoxidized till-like		

Description	Sample No.	Age (yr)
material; 4 ft of unoxidized coarse gravel containing cobbles and a few boulders; 3 ft of peat interbedded with fine sand and silt; 4 ft of unoxidized, coarse gravel containing cobbles and a few boulders; and a thin vegetation mat at the surface. The elevation and character of the deposits, the stratigraphy, and the nearby strandlines suggest that the peat was deposited during a period of glacial retreat, with relatively low lake- and base-level, and that the gravel, which underlies and overlies the peat, was deposited as outwash during periods of glacial advance, with relatively high lake- and base-level. Collected and interpreted by O. J. Ferrians, Jr., and H. R. Schmoll, U.S. Geological Survey, Washington, D.C.		
Peat from base of peat bed.	W-429	11,440 ± 400
Peat from top of peat bed.	W-487	9240 ± 300
Northeastern Copper River Basin, Alaska. Wood collected from a bluff on the east side of the Gakona River about 20 mi from its mouth. The section, from the base upward includes: 35 ft of cover; 5 ft of oxidized fine gravel and sand; 5 ft of slightly oxidized, fine, silty sand with organic material disseminated throughout; forest horizon (sample W-377); 15 ft of unoxidized outwash gravel; and 10 ft of unoxidized stony silt mantled by a thin vegetation mat at the surface. Stratigraphic relations suggest that the 5-ft thick bed of organic silt and sand and the forest zone represent deposition during a major interglacial period which was terminated by a major glacial advance as represented by the overlying outwash deposits. Outwash deposition was followed by a period of glaciolacustrine deposition during the high-level phases of an interior lake that occupied the Copper River Basin. Collected and interpreted by O. J. Ferrians, Jr., and H. R. Schmoll.	W-377	> 35,000
Southwestern Copper River Basin, Nelchina River. Peat collected from the base of stratified peat and cliff-head dune sand deposits at the top of the north bank of the Nelchina River at lat. 62°00′N, long. 146°32.3′W. Below the dated peat lie about 150 ft of glacial drift, chiefly till, which is underlain near the base of the cliff by gravel and sand, and at the base by lake silt. The sand near the base of the cliff was dated as older than 38,000 yr (W-295). Collected and interpreted by J. R. Williams and O. J. Ferrians, Jr.	W-306	975 ± 160
Northern Chugach Mountains, Tazlina Lake Area, Alaska. Black organic silt, containing alder and willow sticks and spruce needles, was collected from a depth of 4 ft in an exposure at the edge of a pond in the upper valley of Tokaina Creek, located at lat. 61°52.5′N, long. 146°19′W. The dated organic silt, interpreted as a pond deposit, is overlain by grass and sedge peat which is interpreted as marsh or bog deposits and is underlain by blue-gray sandy clay which is tentatively interpreted as the deposit of an ice-dammed lake which filled the valley of Tokaina Creek. The dated sample furnishes a minimum age for retreat of the ice and disappearance of the lake, and dates the pond deposits. Collected and interpreted by J. R. Williams and O. J. Ferrians, Jr.	W-378	2500 ± 200
Munday Creek, Yakataga District, Alaska. Small tree rooted in place at the base of a 30-ft section of alluvial sand, gravel, and silt deposited as a fan on a marine terrace at the mouth of the bedrock canyon of Munday Creek. The tree grew at the inner margin of a prominent marine terrace now at an altitude of about 40 ft and is believed to have been buried at an early stage in the formation of the alluvial fan, probably not more than 100 yr after the sea withdrew from this stand. Collected by D. J. Miller, U.S. Geological Survey, Menlo Park, Calif.	W-369	1050 ± 160
Crillon Lake, Lituya District, Alaska. Small tree in a poorly stratified ice-contact deposit on the inner face of and about 10 ft below the crest of the end moraine at the south end of Crillon Lake. The sample gives a maximum age for the last major advance of the South Crillon Glacier to a point about 4.5 mi south of and about 500 ft higher than the present front. If the tree is of local origin, as is indicated by the bark, small limbs, and roots attached, the sample also fixes, within a few tens of years, the beginning of retreat from this stand. The last advance of the South Crillon Glacier is correlated on other evidence with the last advance of ice to the mouth of nearby Lituya Bay, and is possibly about the same age as the last advance of ice to the outer part of Glacier Bay, on the opposite side of the Fairweather Range. Collected by D. J. Miller.	W-371	390 ± 160
Icy Bay, Yakataga District, Alaska. Small pieces of wood in an end moraine exposed in sea cliff west of Icy Cape. The sample gives a maximum age for the older of two major advances of ice into the ocean at the mouth of Icy Bay, 18 mi or more beyond the present tidal front of the Guyot and Tyndall glaciers. The last advance probably culminated during the 18th century and may be the one recorded in native legend (*23*). The presence of many unbroken fragile shells of marine mollusks in till up to an altitude of at least 20 ft in the moraine from which the wood sample was obtained indicates that the older advance occurred during a higher stand of the sea, possibly the stand dated by sample W-369. Collected by D. J. Miller.	W-374	1200 ± 160
Cape Suckling, Katalla District, Alaska. Small tree, one of many rooted in place in stratified peaty mud on beach at approximately 0 tide level. The sample was interpreted as representing a eustatic low sea-level phase, but in view of the result, either local subsidence of the forest to its present position or contamination of the sample is suspected now. Collected by D. J. Miller.	W-376	390 ± 160
Marine Terrace, La Perouse Glacier, Lituya District, Alaska. Small piece of beach-worn driftwood at the base of a 10 ft section of stratified sand and gravel, and immediately above a wave-planed bedrock surface at altitude about 150 ft. The sample gives a maximum and probably nearly correct date for the formation	W-405	3250 ± 200

Description	Sample No.	Age (yr)
of one of the intermediate terraces in the Lituya district. The date is consistent with Heusser's conclusion, based on pollen studies, that a nearby marine terrace at about half this altitude has emerged within the past 2000 yr (*24*). Collected by D. J. Miller.		
Cape Suckling, Alaska. Shells of shallow-water marine mollusks from a sea cliff 12 ft above mean high tide. Collected by D. J. Miller.	W-462	5120 ± 220
Willow Creek, Alaska. Organic silt from pond sediments taken from base of a bog in a lateral moraine complex 2.5 mi west-southwest of the steel bridge at the mouth of Willow Creek Valley, Talkeetna Mountains. Collected by Bjorn G. Andersen, University of Oslo, Norway.	W-360	11,930 ± 250
Talkeetna Mountains, Alaska. Twigs and wood fragments from "beaverpond" sediments at the base of a 7- to 8-ft bog section located in the central Willow Creek Valley, 4 mi down the valley from Lucky Shot mine, in the southwestern Talkeetna Mountains. The bog is in a closed depression within the large main morainal complex in the valley. Sample and interpretation by Bjorn G. Andersen.	W-336	9870 ± 250
Eastern Talkeetna Mountains, Tyone Creek, Alaska. Compressed fibrous peat collected near the base of the 30-ft-high west bank of Tyone Creek at lat. 62°15'N, long. 147°5.9'W. The stratigraphic section exposed in the river bank, from top to bottom is: 3 ft of glacial till, about 4 ft of gravel, 15 ft of slumped material, and 8 ft of interbedded silt and peat which contains a few pods and lenses of oxidized sand and gravel. The silt-peat deposits from which the sample was taken probably represent an interglacial fluvial deposit which was buried, first by outwash and then by glacial ice. Collected and interpreted by J. R. Williams and O. J. Ferrians, Jr.	W-357	> 35,000
Hotham Inlet, Alaska. Peaty material within an organic layer collected 45 ft down from the top of a 100-ft bluff on the north shore of Hotham Inlet between the deltas of the Kobuk and Noatak rivers at lat. 67°02'N, long. 161°59'W. The bluff exposes, from top to bottom: 5 ft of organic silt; 35 ft of stratified sand and silt; 10 ft of organic material, including tree trunks and logs; and 50 ft of gray till. The date is a minimum one for an extensive glaciation in this region. Collected and interpreted by A. T. Fernald and D. R. Nichols, U.S. Geological Survey, Washington, D.C.	W-344	> 38,000
Sheguiandah, Manitoulin Island, Ontario. Peat from basal 1-in. layer of a 5 ft bog section that overlies lake clays containing Indian artifacts, at the Sheguiandah site, swamp area 3, test trench 1. The sample layer lies 135 ft above Lake Huron and above what are believed to be Lake Algonquin clays. A cold episode is recorded in the peat at about the 4-ft level and should correlate with the Cochrane readvance. Collected by T. E. Lee, National Museum of Canada, Ottawa, Ont.	W-345	9130 ± 250
Ste. Anne de Madawaska, New Brunswick. Wood from the bank of the Quisibis River, along the north shore of the St. John River. The section consists of silts, sand, and clay, resting on a bog layer (sample horizon) that overlies gravel and sand from the valley train of St. Jacques drift (*25*). Collected by H. A. Lee, Geological Survey of Canada, Ottawa, Ont.	W-353	8250 ± 200
Grenoble, France. Fragment of a tree, identified as *Pinus* species, from varved clays in a section known in French geologic literature (*26*) as the "Argiles d'Eybens," near Grenoble. The deposit is believed to represent the Third Interglacial (Riss-Würm of Europe, Sangamon of North America). Collected by L. Moret, University of Grenoble; submitted by H. L. Movius, Jr., Harvard University.	W-315	> 37,000
Queensland, Tasmania. Carbonized fragments of King William pine from Linda Moraine, Gormanston, east of Queenstown, western Tasmania. The sample comes from varved clays deposited in a glacially dammed lake at the head of Linda Valley and belonging to the Malannan phase of glaciation (*27*). Submitted by E. D. Gill.	W-323	26,480 ± 800
Henty River, Tasmania. Wood from clays deposited behind a moraine exposed in a railroad cut 0.6 mi north of the bridge over the Henty River, on the line from Zeehan to Strahan. The moraine marks the beginning of retreat of the Malanna ice sheet, the earliest phase of Pleistocene glaciation in Australia. Submitted by E. D. Gill.	W-444	> 32,000
La Paz, Bolivia. Organic matter from the upper part of a thin lake bed deposit, upstream from an end moraine across the Chocayapu River along the road to Chacaltaya in a locality called Patapatani, near city of La Paz (*28*). The lake was dammed by the end moraine, and therefore the organic matter should date sometime postmoraine formation. This moraine is similar in position to many others along the western front of the eastern Andes of Bolivia and seems to represent the last advance of the last glaciation. Collected by E. Dobrovolny, U.S. Geological Survey, Denver, Colo.	W-367	9200 ± 250
Greenland Ice Cap. Organic matter from sediments exposed as a smear in one of the shear planes near the low-cliffed terminus of the North Ice Cap. The sample was collected approximately 65 mi northeast of Thule, Greenland, by R. P. Goldthwait.	W-408	4760 ± 220
III. *Other geologic samples*		
Great Salt Lake, Utah. Samples obtained from a core taken from bottom of Great Salt Lake in 28 ft of water, lat. 40°47.9'N, long. 112°16.6'W. The samples consist of the organic carbon and the carbonate carbon fractions of the intervals 18-to-22.5 ft and 25-to-30.5 ft below the lake bottom. These represent the section of the core containing sediments of fresh-to-brackish water environment, and establish an average age through this thickness of sediments for the last (perhaps the main) Wisconsin fresh-water stage of the lake. Collected by A. J. Eardley and R. Cohenour, University of Utah.		

Description	Sample No.	Age (yr)
Carbonate carbon.	W-319	16,680 ± 300
Organic carbon.	W-321	16,850 ± 300
Searles Lake, Calif. Samples taken from drill hole GS-27 located on Searles Lake, from depth of 78.0 to 78.1 ft. This core presented an excellent opportunity to check the use of various carbonaceous materials for age determinations. Sufficient carbon was obtained from a twig, gaylussite crystals, and organic mud for three separate determinations, all from within a 0.1-ft section of core. The core bottoms at 83 ft in mud. The samples come from the overlying unit, the "lower salt" formation, which extends up to the 58.6-ft depth. Next comes the "parting mud" layer, with its top at 43.3 ft and then comes the "upper salt" with its top at 18.6 ft. Overburden mud extends to the surface. The "parting mud" layer has yielded organic material that was dated by Libby (*29*) at from 10,000 to 24,000 years in proper sequence. This mud represents the last fresh-water stage of the lake. Submitted by D. V. Haines, U.S. Geological Survey, Claremont, Calif.		
Wood from core.	W-340	26,700 ± 2000
Carbonate from gaylussite crystals.	W-341	23,000 ± 1400
Organic carbon from mud.	W-343	29,500 ± 2000
Harrisville, Utah. Carbonaceous material from well-developed soil 0.5 to 1.0 ft thick, about 11 ft below the land surface, exposed in a clay pit of the Harrisville Brick Co. SW¼SW¼NE¼ sec. 6, T6N, R1W, Weber County, north of Ogden. The soil is the uppermost of three soils displayed in the pit, at 4290-ft elevation; it is considered post-Lake Bonneville group by collector, J. H. Feth, U.S. Geological Survey, Menlo Park, Calif.		
Plant remains from soil.	W-335	8330 ± 300
Shells from same soil.	W-385	7720 ± 300
Hooper, Utah. Plant stems from the bank of the U.S. Bureau of Reclamation's Hooper Pilot Drain in center sec. 8, T5N, R2W, southwest of Ogden, Weber County. Woody matter at 4235-ft elevation was in growth position in gray sand 6 ft below the land surface. Considered post-Lake Bonneville group by collector, J. H. Feth.	W-386	9730 ± 350
Great Salt Lake, Utah. Algal tufa from beaches of former Lake Bonneville, from the north end of the Oquirrh Range, just west of Garfield. Collected by A. J. Eardley, University of Utah.		
Tufa from Lake Bonneville shoreline, elevation 5200 ft.	W-409	11,300 ± 300
Rerun of W-409, from weathered portion.	W-439	11,420 ± 300
Tufa from Provo shoreline, elevation 4800 ft.	W-410	> 32,000
Tufa from Stansbury level, elevation 4520 ft.	W-411	14,000 ± 450
Tufa from Stansbury level, elevation 4480 ft.	W-412	14,000 ± 450
Weber River, Utah. Samples from section exposed on the northwest wall of a small canyon extending northeast from the floodplain of Weber River into Uintah bench, in the SW¼ sec. 21, T5N, R1W. Weber County. Collected by J. H. Feth and M. Rubin.		
Peat from 1 in. thick bed underlying 13 ft of marl and clay, elevation 4600 ft.	W-326	9925 ± 300
Rerun of W-326.	W-440	10,260 ± 300
Marl immediately above peat.	W-382	12,960 ± 350
Pyramid Lake, Nev. Lithoid tufa from the top of Anaho Island, Pyramid Lake, at elevation 4376 ft, about 30 ft below the highest level of Lake Lahontan. Collected by J. W. Calhoun, Nevada State Museum, Carson City, and P. C. Orr, Western Speleological Institute, Santa Barbara, Calif.	W-442	12,050 ± 400
Pleasant View, Utah. Tufa from various levels on the southwestern tip of Pleasant View salient, a spur of Cambrian limestone and quartzite from the Wasatch Range, 10 mi north of Ogden. The samples were collected by J. H. Feth, to date the stages of Lake Bonneville.		
Tufa with snail shells from limestone pinnacle at elevation 4975 ft (Alpine level).	W-455	14,030 ± 500
Tufa encrusted on low knob of limestone at elevation 4800 ft (Provo level).	W-456	11,650 ± 450
Tufa with snail shells from roof of wave-cut cave at the same level as W-456.	W-458	14,380 ± 500
Stansbury Mountains, Utah. Tufa from various levels of Lake Bonneville. Collected by J. H. Feth and H. Waite, U.S. Geological Survey, Menlo Park, Calif.		
Tufa from Stansbury level on a ridge west of the main Stansbury Range, 3 mi south of Timpie.	W-490	16,530 ± 800
Tufa from Provo level, above W-490.	W-491	13,380 ± 400
Tufa from low-level Stansbury, encrusting the top of a ridge in Skull Valley, west of Stansbury Mountains, 4 mi south of the railroad.	W-494	18,000 ± 1000
Assawompsett, Mass. Log from hearth buried by 1 m of eolian sand on which a normal brown podzolic soil profile has developed, exposed at Assawompsett Pond on Vaughan St. The log would antedate the eolian activity and the soil development. Collector, J. H. Hartshorn, U.S. Geological Survey, Boston, Mass.	W-363	4320 ± 250
Washington, D.C. Wood from a peat layer encountered in excavation made in 1955 for an annex to the Mayflower Hotel. Peat was overlain by 10 ft of muck, which in turn was overlain by 10 ft of sand and clay. Collected by C. Milton and M. Rubin.	W-302	> 38,000
Spartanburg, S.C. Wood taken from peaty clay in an exposure on a small tributary to Buck Creek, of the Pacolet River drainage basin, 13 mi north of Spartanburg. Submitted by W. C. Overstreet, U.S. Geological Survey, Shelby, N.C.	W-308	> 34,000
Evansville, Ind. Wood from Megalodon beds in river alluvium near Evansville. Collected by Leo Lesquereux in 1870 from strata containing a mammalian faunal assemblage including *Megalonyx, Bison, Equus, Tapirus,* and *Odocoileus.* The section has been referred to both the Sangamon and Yarmouth intervals (*30*). Submitted by E. S. Barghoorn, Harvard University, and L. L. Ray, U.S. Geological Survey, Washington, D.C.	W-418	9400 ± 250
Yankeetown, Ind. Wood from the Indiana bank of Ohio River, approximately 1000 ft west of the Warrick-Spencer county line, sec. 26, T7S, R8W, in laminated silts 5 ft above the pool stage of the river. Collected by L. L. Ray.	W-428	4030 ± 160
Lonoke County, Ark. Charcoal and wood fragments taken from 50-ft depth in a well	W-316	5520 ± 160

Description	Sample No.	Age (yr)
located in the NW¼NE¼ sec. 22, T1N, R10W. The sample comes from a layer of sands and gravels underlying silts and clays. Well bottomed in Tertiary clay at 86 ft. Collected by P. E. Dennis, U.S. Geological Survey, Little Rock, Ark.		
Sitka, Kan. Bunch grass collected on Harper Ranch, 6 mi south of Sitka, Clark County, by Harmon and Claudia Craig on 7 Oct. 1955. Grass from this location had previously been found by Craig to be greatly enriched in C^{13} relative to the range of normal terrestrial plants (*9*, p. 70), and he interprets such enrichment as being due to assimilation of carbon from limestone-derived carbonate in a pedocalcic soil (*9, 31*). The C^{13}/C^{12} ratio in caliche from this area is the same as that of average limestone for which δC^{13} is about 0 per mil (*31*). This sample was collected to determine whether vegetation in such an area would show an apparent C^{14} age due to assimilation of "old" carbon from caliche and soil carbonate. A series of new C^{13} analyses on grass from this area, made by H. Craig, gave a δC^{13} value for this sample of -11.0 per mil, and values of -12.1 per mil and -12.9 per mil, respectively, for bunch grass and buffalo grass growing together about 100 yd from the spot at which the present sample was collected (normal terrestrial plants average -25 per mil). All samples were treated with HCl to remove any carbonate. It was believed, therefore, that the grass would show a radiocarbon age of several thousand years if the soil carbonate contained no radiocarbon. However, the radiocarbon measurement gives a C^{14} activity 4.5 percent higher than that of our modern standards (*32*), which, when corrected for isotopic fractionation in preparation of C_2H_2 by comparison of C^{13} analyses of combusted C_2H_2 and combusted grass, becomes 5.4 percent, which is equivalent to 430 years in the future. (Combusted C_2H_2, analyzed by T. Mayeda, gave $\delta C^{13} = -15.4$ per mil. This activity is not corrected for the C^{13} difference between the grass and our wood standards because derivation of carbon from two sources is involved and because the radiocarbon content of the soil carbonate is not known. The anomalously high activity must represent a recent addition of radiocarbon to the atmosphere from nuclear weapons and reactors, which is gradually increasing the C^{14} content of atmospheric CO_2. Except for the effect of natural isotopic fractionation, the figure of 5.4 percent is a lower limit for the addition as of 1955, which has evidently been sufficient to overcompensate for any "dead" carbon assimilated; however, because the radiocarbon content of the soil carbonate has not been measured, an exact value for the atmospheric radiocarbon increase cannot be given. On the other hand, it is highly improbable that more than a few percent of artificially produced radiocarbon had been added by 1955, and thus it seems that, in the process of continual solution and reprecipitation, the soil carbonate has been brought up almost to modern radiocarbon content.	W-350	+5.4% (see discussion)
Kassler quadrangle, Colo. Molar of *Mammuthus* (*Parelephas*) from pebbly clay at the "Spring site" in NW¼NE¼ sec. T6N, R69W, Kassler quadrangle. Collected by G. Scott, U.S. Geological Survey, Denver, Colo.	W-401	10,200 ± 350
Yellowstone, Wyo. Section of lodgepole pine taken from an erosion channel on the northeast side of the cone of Old Faithful Geyser, near the base. The sample dates a quiescent period in the formation of the mound and verifies the collector's figure of about two centuries for the beginning of the eruption of the present Old Faithful Geyser (*33*). Collected by G. D. Marler, Thornton, Idaho, and submitted by H. Craig, Scripps Institution of Oceanography, La Jolla, Calif.	W-311	730 ± 200
Beartooth Mountains, Wyo. Peat from a deposit 1 mi south of Sawtooth Mountain, T57N, R104W, on Deep Lake quadrangle at elevation 9700 ft. Collected by W. G. Pierce, U.S. Geological Survey, Menlo Park, Calif.	W-459	7570 ± 400
American Falls Reservoir, Idaho. Charcoal from American Falls lake bed area, taken from beneath the facial portion of a skull of *Bison gigantobison latifrons* in sands 2 to 3 ft below the surface at Michard Flats. The purpose of dating was to establish a range for this species. Collected by M. L. Hopkins, Idaho State College.	W-358	> 32,000
East Tintic, Utah. Charred wood from the west bank of a main stream channel cut into a Recent terrace, in the west-central part of sec. 26, T8S, R4W Salt Lake Meridian. Collector: H. D. Goode, U.S. Geological Survey, Denver, Colo.	W-421	470 ± 160
Sulphur Bank, Calif. Log from preandesite lake beds at Sulphur Bank, the locality of one of the largest producers of mercury in the United States. All the mercury of the deposits was precipitated after this log and the enclosing lake beds were deposited. Collected by D. E. White, U.S. Geological Survey, Menlo Park, Calif.	W-362	> 33,000
Sacramento, Calif. Wood from a depth of 60 ft in a Ranney well dug for city of Sacramento at the end of Sixth Avenue. The wood occurs in the coarse gravels and sands underlying the fine-grained deposits of the upper 28 ft. The coarse, gravelly deposits which continue to a depth of 104 ft are presumed to represent backfill laid down during rise of sea level concurrent with glacier recession in post-Wisconsin time. Collected by G. H. Davis, U.S. Geological Survey, Sacramento, Calif.	W-436	2240 ± 250
Hermit's Cave, N.M. Samples from cave in Guadalupe Mountains, Eddy County. Collected by C. B. Schultz, University of Nebraska, and submitted by G. E. Lewis, U.S. Geological Survey, Denver, Colo.		
Charcoal from hearth, extinct mammal horizon, 3.2 ft below bench mark A, square 13.	W-495	12,900 ± 350
Log from extinct mammal horizon near hearth of square 13, 2 ft below floor of cave, square 14.	W-498	11,850 ± 350
Log at mouth of cave, 2.7 ft below datum point A, square 26.	W-499	12,270 ± 450
Orting, Wash. Wood taken from a drainage ditch at southwest corner SE¼NW¼ sec. 4, T18N, R5E, Pierce County, 1.5 mi		

Description	Sample No.	Age (yr)
south southeast of Orting. The sample was taken to date the mud flow deposits in the Puyallup River valley floor. Collector, D. R. Crandell, U.S. Geological Survey, Denver, Colo.		
Wood from drainage ditch.	W-407	< 200
Rerun of above wood, to verify date.	W-424	< 200
La Crosse, Wash. Wood from postscabland alluvial silts, 5 ft above contact with scabland gravel and 20 ft below ash layer that is 5 ft below surface. Exposed in the NE¼ sec. 25, T15N, R38E, southwest corner of La Crosse, Wash., quadrangle. Collected by L. M. Gard, U.S. Geological Survey, Denver, Colo.	W-486	6120 ± 300
Hilo, Hawaii. Charcoal buried in volcanic cinder, 6.48 mi S41°W of Coconut Island. The samples come from a prehistoric vent of the last (Kau volcanic series) group of lavas of Mauna Loa. Collected by Stephen Ho; submitted by G. A. Macdonald, U.S. Geological Survey, Denver.		
Charcoal.	W-477	2000 ± 250
Charcoal.	W-478	2070 ± 250
Puna, Hawaii. Charcoal from nearly horizontal 4-in. layer of tree mold in pahoehoe lava, found 1.07 mi N33°W of Makaaiea point in the Puna district of the island of Hawaii. The sample represents uppermost prehistoric flow of the Puna volcanic series. Collected by G. A. Macdonald, U.S. Geological Survey, Menlo Park, Calif.	W-359	< 200
Bikini Island, Marshall Islands. Coral and reef detritus from core in drill hole 3, south end of Bikini Island. The sample came from a depth of 60 ft, just above a stratigraphic break. Submitted by J. I. Tracey, U.S. Geological Survey, Washington, D.C.	W-417	> 38,000
Prince Patrick Island, Northwest Territories, Canada. Driftwood from strand line at elevation 490 ft, at lat. 76°18'N. long. 119°36'W. Submitted by J. G. Dyer, U.S. Weather Bureau, Washington, D.C.	W-423	> 38,000
Mexico, D.F., Mexico. Carbon and carbonate from soil surrounding a giant armadillo found in the Becerra formation near the town of San Miguel Tecamachalco, west of Mexico City. Submitted by A. R. V. Arellano, Instituto Geologico, Mexico, D.F.		
Carbonate fraction of soil.	W-488	8540 ± 350
Organic carbon from soil.	W-493	7940 ± 300
Thjórsárbrú, southwestern Iceland. Peat buried by lava exposed in west bank of Thjórsá River at new bridge on the high road 76 km east of Reykjavik. The sample came from the top of a 20-cm peat bed overlying coarse unconsolidated postglacial sediments, and was overlain by a huge basaltic lava flow, oldest of the Thjórsá lavas. The lava is considered by the collector to be one of the greatest postglacial lava flows recorded, for it covers an area of 800 km² with a volume of 22 km³. Collected by G. Kjartansson, Museum of Natural History, Reykjavik, and submitted by A. Löve, University of Montreal.	W-482	8065 ± 400
Kärlich, Rheinland, Germany. Wood found in a clay pit, from the *Brockentuff* horizon between the underlying Würm II loess and the overlying Würm III loess. The *Brockentuff* is the result of small gas eruptions which brought Tertiary material up through fault zones and deposited it on top of the Würm II loess. The samples therefore do not date the time between Würm II and Würm III, according to the submitter, E. A. Rosauer, Mineralogisches Institut, Bonn-am-Rhein, Germany.	W-303 W-305	> 38,000 > 38,000
IV. *Archeology*		
Newcastle, Me. Mya and other shells collected from the largest oyster shell heap on the Glidden estate on the west side of the Damariscotta River, New Castle. These shell heaps are famous among archeologists, yet their age had never been determined previously. Collector, W. H. Bradley.		
Shells from near base of heap.	W-337	1710 ± 160
Shells from near top of heap.	W-342	1610 ± 160
Yanhuitlán, Oaxaca, Mexico. Charcoal from fireplace of human origin, from 2 km north northeast of Yanhuitlán. Culture represented is believed to be preceramic. Collected by José L. Lorenzo, National Institute of Anthropology and History, Mexico, D.F.; submitted by C. Fries, U.S. Geological Survey, Washington, D.C.		
Charcoal from fireplace.	W-479	4050 ± 200
Charcoal from among rocks of the foundations of walls at the site.	W-480	3950 ± 200
Nazca, Peru. Offertory material placed under and in a stone cache at center of lines that are erected along points of astronomical observation, near Nazca. Collected by M. Reiche; submitted by C. Evans, U.S. National Museum.	W-310	< 200
Nazca, Peru. Charcoal from Paracas culture from site N-4 (cahuachi) strata cut 1, 3.75 to 4.00-m level. Submitted by W. D. Strong, Columbia University.	W-422	2080 ± 160
Uenae site, Hokkaido, Japan. Charcoal from pit 2, Uenae site, 9 mi south of Chitose, from the Later Jomon period. Collected by H. MacCord, U.S. National Museum.	W-322	3230 ± 160
Taniguchi site, Hokkaido, Japan. Charcoal from a layer which seems to represent the Middle Jomon period, based on the pottery classification, from pit 1, Taniguchi site, 12 mi north of Sapporo. Collected by H. MacCord.	W-372	3950 ± 200
Tanaka site, Hokkaido, Japan. Charcoal from roof beams of a burned house, which seemed to date (previous to analysis) from the protohistoric period in Hokkaido. The site is at Osatsu, 8 mi north of Chitose. Pottery from the site is known as "Satsumon" type. Collected by H. MacCord.	W-419	1100 ± 160
Wadi Beihan, Western Aden Protectorate, South Arabia. Charcoal from burned beam at Hajar Bin Humeid mound. The mound consists of 10 major superimposed occupational strata. Sample comes from stratum 2, phase 2 from the bottom, in a context of occupational debris and potsherds. This date confirms the pottery chronology for pre-Islamic South Arabia set up by G. W. Van Beek (*34*). Collected by D. W. Dragoo, Carnegie Museum, and G. W. Van Beek, Johns Hopkins University, and submitted through W. F. Albright, Johns Hopkins University.	W-437	2800 ± 160

References and Notes

1. Publication authorized by the director, U.S. Geological Survey.
2. H. E. Suess, *Science* **120**, 5 (1954).
3. ———, *ibid.* **120**, 467 (1954).
4. M. Rubin and H. E. Suess, *ibid.* **121**, 481 (1955).
5. ———, *ibid.* **123**, 442 (1956).
6. H. Craig, *Tellus* **9**, 1 (1957); R. Revelle and H. E. Suess, **9**, 18 (1957).
7. H. E. Wright, Jr., and M. Rubin, *Science* **124**, 625 (1956).
8. J. H. Feth and M. Rubin, "Radiocarbon dating of wave-formed tufas from the Bonneville Basin," paper presented at the Geol. Soc. of America, Cordilleran sec. meeting, Los Angeles, Calif., 20 April 1957.
9. H. Craig, *Geochim. et Cosmochim. Acta* **3**, 53 (1953).
10. R. P. Goldthwait, *Ohio J. Sci.*, in press.
11. J. L. Forsyth and A. La Rocque, *Bull. Geol. Soc. Am.* **67**, 1696 (1956).
12. W. J. Wayne and W. D. Thornbury, *Guidebook*, 5th biennial Pleistocene Field Conf., Indiana-Ohio, stop No. 14, September 1955.
13. L. Horberg, *Illinois State Geol. Survey, Rept. Invest.* **165**, No. 22 (1953), p. 48.
14. F. C. Baker, *Univ. of Ill. Bull. No. 17* (1920).
15. W. S. Cooper and H. Foot, *Ecology* **13**, 63 (1932).
16. J. D. Love, *Guidebook; 11th Ann. Field Conference*, Wyoming Geol. Assoc. (1956).
17. T. N. V. Karlstrom, *Bull. Geol. Soc. Am.* **66**, 1581 (1955).
18. ———, *U.S. Geol. Survey Bull. No. 1021-J* (1956).
19. F. S. MacNeil, J. B. Mertie, Jr., H. A. Pilsbury, *J. Paleontol.* **17**, 69 (1943).
20. D. M. Hopkins, *Proc. 20th Intern. Geol. Congr.*, in press.
21. W. S. Broecker, J. L. Kulp, C. S. Tucek, *Science* **124**, 156 (1956).
22. D. R. Nichols, *U.S. Geol. Survey Open File Report* (1956).
23. R. S. Tarr and L. Martin, *Alaskan Glacier Studies* (1914).
24. C. J. Huesser, *Am. J. Sci.* **252**, 106 (1954).
25. H. A. Lee, *Can. Dept. Mines and Tech. Surveys, Geol. Survey Paper 55-15* (1955).
26. L. Moret, *Trav. lab. géol. fac. sci. univ. Grenoble* **32**, 11 (1954–55) (1956).
27. S. W. Carey, *Australian J. Sci.* **17**, 176 (1955).
28. E. Dobrovolny, *U.S. Geol. Survey Open File Report* (1955).
29. W. F. Libby, *Radiocarbon Dating* (Univ. of Chicago Press, Chicago, Ill., ed. 2, 1955), p. 116.
30. F. C. Baker, *Univ. of Illinois Bull. No. 17* (1920), p. 274.
31. H. Craig, *J. Geol.* **62**, 115 (1954).
32. H. Suess, *Science* **122**, 415 (1955).
33. G. D. Marler, *Am. J. Sci.* **254**, 615 (1956).
34. G. W. Van Beek, *Bull. Am. Schools of Oriental Research* **6** (1956).

Karl Lark-Horovitz, Physicist and Teacher

The death of Karl Lark-Horovitz, on 14 April 1958, brought an end to an active and creative career devoted to the advancement of teaching and research in physics.

He was born on 20 July 1892, in Vienna, where he received his entire formal education. His studies at the University of Vienna, chiefly in the field of chemistry, were interrupted by a period of service in the Austrian army during World War I. He received his doctorate in physics in 1919, and taught at the University of Vienna until 1925. His early publications, some of which preceded his doctoral thesis, ranged over the subjects of radioactivity, relativity, the electromotive force of dielectrics, and visual space perceptions by the human eye. This wide field of scientific interest had its counterpart in a breadth of interest in other intellectual areas; for instance, his minor for the Ph.D. was on the ideas of pre-Socratic philosophers. It was further reflected in his later interests and achievements in science, which ranged from the physics of the solid state to biophysics, from x-rays to nuclear investigations, and from the physical investigation of the qualities of good violins to practical considerations on the production of glass.

In 1925 he was awarded an International Research Council fellowship, which brought him first to the University of Toronto, then successively to the University of Chicago, the Rockefeller Institute for Medical Research, and Stanford University. He delivered several lectures at Purdue University in the spring of 1928, and was invited to join the staff as professor of physics. He was appointed director of the Physical Laboratory in 1929, and head of the department in 1932; he held these positions until his death.

From the time of his arrival at Purdue, Dr. Lark-Horovitz played an active role in the reorganization and the teaching of undergraduate courses. He integrated ideas from chemistry, biology, and philosophy into the program of the general physics courses. He organized his material to emphasize the growth of the science of physics as one aspect of the history of civilization and to show the effect of scientific discovery on the social and economic development of society. The courses he taught to the science and nonscience majors in the early 1930's had many of the qualities of modern general education courses. The revisions and innovations he made in the physics courses for engineers also served to attract some of the ablest students to the field of physics.

At the beginning, he also carried a major fraction of the teaching load of the graduate program, as well as the entire burden of the direction of research. He began to develop a program of research in x-rays and the physics of surfaces with a tiny budget and improvised equipment. The success of this work soon led to increased financial support of research in physics. By 1936, elaborate equipment, such as the cyclotron, began to be acquired by a combination of purchase and of construction by the talented and enthusiastic group of graduate students that Dr. Lark-Horovitz had trained. His many graduate students would agree that he was an exacting taskmaster, but one who was extremely fertile in ideas, who had an exceptional familiarity with the pertinent literature, and who succeeded in communicating some of his own vigor and enthusiasm to them.

From 1936 to 1942 the research interests of Dr. Lark-Horovitz were concentrated in the field of nuclear physics. He made attempts to observe neutron diffraction with sources which, it is known now, had inadequate intensity. He began programs of work on nuclear reactions and investigated the fission of the uranium nucleus. He undertook investigations of cosmic rays with photographic plates sent up by balloon, and investigated biophysical problems by using radioactive tracers. His research interests were always up-to-date.

In 1942 he brought to Purdue a defense contract that turned his interest finally in the direction of solid-state physics. The contract was concerned with the development of crystal rectifiers, and his experience as a chemist led him to the wise choice of germanium as a material for investigation. He, and the group that he gathered around him, made rapid progress in the purification of this material, and applied new methods to the analysis of its behavior. Some

of the devices developed by this group were of great and lasting value. In addition, his work provided a foundation for the later development of the transistor at other laboratories.

After the end of the war his interests turned largely toward a study of the fundamental properties of semiconductors, as disclosed by systematic measurements of a great variety of their properties under a wide range of conditions. A major contribution from this period was his opening up of the field of study of semiconductors bombarded by energetic particles, which has thrown much light on the production and effects of lattice defects in crystals. Throughout this development, Dr. Lark-Horovitz' wide-ranging interests and knowledge of physics made him an effective catalyst and coordinator of the group working around him.

Worthy of special mention in this place are the contributions of Professor Lark-Horovitz to the work of the AAAS. He was general secretary from 1947 to 1949 and a member of the AAAS Editorial Board from 1949 to the time of

his death. His colleagues testify to the great energy that he brought to this work and to the high value of his contributions. He was an original member of the AAAS Cooperative Committee on the Teaching of Science and Mathematics, and chairman of the committee from 1945 to 1950. His activities on behalf of this committee were indicative of his strong interest in the teaching of science at all levels, from kindergarten to graduate school. He was influential in the preparation of numerous reports, such as "The preparation of high school science teachers" and "Manpower for research," a report to the President of the United States by the President's Scientific Research Board. His work had direct effect in producing an improvement in the requirements for the certification of science teachers in his home state of Indiana. He received from the American Association of Physics Teachers a Distinguished Service Citation for exceptional contributions to the teaching of physics.

In recent years the work of Dr. Lark-Horovitz was hampered by continuous ill health, but he never surrendered to his difficulties. His death came as he wished it, while he was engaged in an active program of work in a wide range of fields. He will be greatly missed by his many friends and associates.

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News of Science

Strauss Retires

Lewis L. Strauss retires on 30 June as chairman of the Atomic Energy Commission after 5 years as the principal director of the atomic energy program. However, Strauss will remain in the Administration as special assistant to President Eisenhower in the President's atoms-for-peace program. The disagreement between Strauss and some members of the Joint Congressional Committee on Atomic Energy is said to have strongly influenced Strauss in his decision to retire.

One of the principal objections to Strauss has been that for the last 5 years he has also been special adviser to the President on atomic energy, and thereby has been able to circumvent the commission in influencing the Administration's atomic policy. An editorial in the 6 June *Christian Science Monitor* said:

"Retirement of Admiral Strauss as chairman of the Atomic Energy Commission marks the end of an era. For five years he had dominated American atomic policies.

"Not without controversy. His emphasis on secrecy brought him into sharp conflict with the press, and influential members of Congress often differed with him vigorously on major policies. The AEC was sometimes divided. But, serving also as special adviser to the President and being a man of ability and tenacious purpose, Mr. Strauss very generally prevailed.

"No one questioned his patriotic dedication. But much opinion had developed both among technical experts and in Congress holding that less rigid attitudes would also serve national security. His opposition to a ban on bomb tests had recently been by-passed in the naming of experts to talk with the Russians about policing a ban. Mr. Strauss had himself modified his earlier opposition to sharing atomic information. . . .

"Cooperation between the Joint Congressional Committee on Atomic Energy and the AEC is especially essential. We trust that in the period ahead new hopes for more flexibility and cooperation will be realized."

John A. McCone, a West Coast businessman and former Under Secretary of the Air Force, has been nominated to succeed Strauss on the AEC. McCone has been closely connected with West Coast shipbuilding and ship-operating interests and is president of Joshua Hendy Corporation in Los Angeles, a steamship operating concern. In announcing the nomination the White House did not say that McCone would succeed Strauss as chairman of the five-man commission. The President will not designate the new chairman until the Senate has acted on the nomination. A *New York Times* article on McCone commented that "The immediate reaction of Democrats on the Atomic Energy Committee was restrained but friendly, raising the possibility that the McCone nomination may restore some degree of harmony between the committee and the commission."

Britain's Nuclear Power Program

Less than 16 months ago, Calder Hall, the first full-scale nuclear energy power station in the world, began to feed electric power into Britain's national grid. Now, four new and considerably more powerful stations are under construction, and sites are being explored for others. The great progress which has been made in plant design and technology, without any fundamental change in nuclear physics, is reflected in Table 1.

In March 1957, the Government revised the nuclear power program of February 1955 by virtually trebling the capacity planned for 1966, from 1500–2000 to 5000–6000 megawatts. But, thanks to the tremendous rate of advance of the last year and a half, 12 stations, the same number envisaged in 1955, will be capable of providing the new capacities.

Limitations on size receding. At first, it was thought that 19 stations would be required. Since the technical limitations on the size of nuclear power stations are rapidly receding, it is even possible that the figure of 12 with a total capacity of 6000 megawatts may not be the final number of stations operating in 1966. According to the latest information available, it is now feasible to build a single reactor capable of producing substantially more net electrical output—400 megawatts—than the first four complete stations listed in Table 1. This means that atomic power stations with a capacity of 800 megawatts can now be built and are likely to feature in the second group of stations to be constructed.

A number of factors have contributed to this development. The size of the reactor has increased, and with it the amount of uranium fuel. New welding techniques, based on the experience acquired in building Calder Hall, have made possible the increased size of the pressure vessel which houses the reactor. While in the case of Calder Hall 2-inch steel plates were the limit, it is now possible to weld 3-inch and possibly even 3½-inch plates. And the resulting increase in size of the pressure vessel has allowed core diameters to be raised from 35 feet at Calder Hall to 50 feet at Hunterston.

Table 1. Progress in plant design and technology.

Plant	Net electric output (Mw)	Heat output per reactor (Mw)	Uranium (ton)
Calder Hall	138	143.7	117
Berkeley	275	530	250
Bradwell	300	531	240
Hunterston	320	535	249
Hinkley Point	500	966	375

Table 2. Cost per unit of power generated.

Date	Nuclear (pence)	Conventional (pence)
1960	0.66	0.60
1970	0.47	0.66
1980	0.37	0.73

Cost of nuclear power will fall quickly. At the beginning, the new nuclear stations now under construction will generate electricity at a cost slightly higher than would be possible from the latest coal-fired power stations in Britain. But according to the calculations made by Sir Christopher Hinton, formerly in charge of industrial development at the United Kingdom Atomic Energy Authority, and now chairman of Britain's new Central Electricity Generating Board, the cost of electricity produced by nuclear and conventional power plants should be strictly competitive in 1962. By 1982 the cost of electricity produced by atomic power might well have fallen to half that of electricity from coal. The figures in Table 2 indicate the progress expected between 1960 and 1980. The improved efficiency of conventional generating plants will be offset by the increasing cost of mining coal.

In arriving at the calculations of the cost of nuclear electricity, allowance has been made for the fact that most of the nuclear stations from 1970 onward, like many of the conventional power stations today, have to operate on less than baseload. In fact, it is assumed that the rate of 80 percent of the 24 hours in each day during which the first nuclear stations would be operated would drop to 70 percent in 1970 and 65 percent in 1980. It is also worth stressing that all figures for electricity generated by nuclear energy have been worked out on present reactor and technological plans. Obviously, progress in fundamental research or technology may produce still more favorable results.

Research into new types of reactors. A great deal of research into new types of reactors is going on in the laboratories both of the U.K. Atomic Energy Authority and of the firms directly concerned with the construction of nuclear power plants. And intensive work is proceeding to realize the full potentialities of the gas-cooled graphite-moderated Calder Hall type of reactor which, it is visualized, will be used in stations to be built under the present program. One of the most important long-term objectives is the reduction of fuel costs by utilization of a higher proportion of the total uranium fed to the system. Recycling of the plutonium produced during the operation of the reactor might increase the burn-up rate by as much as a factor of five. In practical terms this would make 1 ton of uranium equivalent to 50,000 tons of coal, as against 10,000 tons in the case of the first Calder Hall reactor.

Perhaps the most striking feature of the rapid rate of progress in using atomic energy for peaceful purposes on a large scale in Britain is the fact that industry came in at an early stage to undertake commercial development of reactor systems designed by the U.K. Atomic Energy Authority. All power stations are being developed on a competitive basis by groups of British engineering and construction firms, supported by other companies specializing in the manufacture of the vast ranges of electronic and other measuring and ancillary equipment needed. All of them are able to call on the Atomic Energy Authority's basic knowledge, and they are thus able to accumulate a large amount of experience and to create great manufacturing capacities.

STEPHEN E. SCHATTMANN
London, England

Exchange of Agricultural Observers

The U.S. Department of Agriculture has announced that it will send six agricultural groups to the Soviet Union this summer and early fall, and that the U.S.S.R. will send a similar number to the United States. Three additional teams from each country are to be exchanged in 1959. The delegation exchange plan is in accordance with last January's agreement between the United States and the Soviet Union providing for a general program of exchanges in cultural, technical, and educational fields.

The teams going to the Soviet Union will be the first groups sponsored by the U.S. Department of Agriculture to have an opportunity to visit Russian farms, research stations, and institutions, and learn what agricultural developments have taken place in the U.S.S.R. The Russian visitors will have opportunity for similar observations in this country. Each of the U.S.–Russian delegations will be seeking specific scientific or technical knowledge. Accordingly, the membership of each American delegation has been selected from among U.S. Department of Agriculture and Land Grant institution specialists.

The U.S. delegations going to the Soviet Union in 1958, by subject interest and probable date of departure, are: agricultural economics, 25 June; agricultural crops, 5 July; soil and water use, 10 July; veterinary science, 15 July; mechanization of agriculture, 18 August; and cotton growing and plant physiology, 1 September. There are plans to

send three additional teams in 1959 in the following fields: (i) forestry, lumbering and millwork; (ii) sheep raising; and (iii) biological control of agricultural pests.

The United States expects to receive from the Soviet Union this summer teams in the following fields: irrigation and reclamation, June–July; forestry, lumbering and millwork, July-August; mechanization of agriculture, August; animal husbandry, September-October; agricultural construction and electrification, September–October; and veterinary science, October–November. In 1959 additional delegations are to be received from the U.S.S.R. as follows: (i) mixed feeds; (ii) cotton growing; and (iii) horticulture.

Grants, Fellowships, and Awards

Biology and medicine. The Division of Biological and Medical Sciences of the National Science Foundation has announced that the next closing date for receipt of basic research proposals in the life sciences is *15 September.* Proposals received prior to that date will be reviewed at the fall meetings of the foundation's advisory panels, and disposition will be made approximately 4 months after the closing date. Proposals received after the 15 September closing date will be reviewed following the winter closing date of 15 January 1959. Inquiries should be addressed to the National Science Foundation, Washington 25, D.C.

Medical writing. The editors of *Modern Medical Monographs,* a quarterly publication, have announced an award for the best unpublished manuscript for a short book on a clinical subject in the field of internal medicine. The purpose of this award, which will be known as the Modern Medical Monograph Award, is to stimulate young physicians to communicate their work in the classical form of the monograph and to achieve high standards of medical writing. The winner of the competition will receive $3500. In addition, the winning monograph, if found suitable, will be published as a book in the series *Modern Medical Monographs.* Henry M. Stratton, president of Grune and Stratton, Inc., publishers of the series, has made the award possible. The entries will be judged for style and clarity of expression by a committee of the American Medical Writers' Association, and for clinical interest and scientific value by the editors and advisory board of Modern Medical Monographs.

The author must be a graduate physician, less than 40 years of age. Single authorship is preferred, but two coauthors will be acceptable. Manuscripts should be submitted in duplicate (original and one copy) by registered mail, postmarked *no later than 1 October 1958,* to Dr. Richard H. Orr, 37 E. 67 St., New York 21, N.Y.

Neurochemistry. A postdoctoral training program in neurochemistry is being organized at Columbia University with the financial support of the National Institute of Neurological Diseases and Blindness, U.S. Public Health Service. The program is under the auspices of the departments of biochemistry and neurology at the College of Physicians and Surgeons and will be directed by David Nachmansohn and Irwin B. Wilson.

Several fellowships are available for periods of 2 to 3 years. The stipend is dependent on previous experience. A doctor's degree in chemistry, biology, or medicine is prerequisite. For application or information write to: Dr. David Nachmansohn, College of Physicians and Surgeons, Columbia University, 630 W. 168 St., New York 32, N.Y.

Nutrition. The National Vitamin Foundation invites individuals who hold doctoral degrees in medicine or one of the biological sciences and who are interested in continuing their training in nutrition, to become candidates for a National Vitamin Foundation–Russell M. Wilder fellowship. The fellowship is for 3 years and pays the recipient $4500 the first year, $5000 the second year, and $5500 the third year. It becomes effective in July or September 1959. Application forms may be obtained from the offices of the National Vitamin Foundation at 149 E. 78 St., New York 21, N.Y. Completed forms must be submitted *before 1 September.*

Science teaching. The National Science Foundation has announced that proposals are now being accepted for the support of 1959 Summer Institutes for the supplementary training of high school and college science and mathematics teachers. Universities and colleges that wish to sponsor such institutes are invited to request information from the Program Director for Summer Institutes, National Science Foundation, Washington 25, D.C. Deadline for the submission of proposals in final form is *1 August.*

One hundred and twenty-five institutes are scheduled for the summer of 1958 in 47 states, the District of Columbia, Alaska, Hawaii, and Puerto Rico. Increasing Congressional support of the program makes it desirable for the foundation to plan now to triple the number of institutes to be held during the summer of 1959.

Foundation support enables sponsoring institutions to pay stipends to participating teachers, plus allowances for dependents and travel; it also contributes toward operational costs. The number of teachers varies from institute to institute, but averages about 50. (Teachers submit applications directly to the sponsoring institution, not to the foundation.)

The number of institutes for high school and junior high school teachers will probably exceed 300 in the summer of 1959. About 10 percent of the 160,000 science and mathematics teachers in secondary schools of the country will be able to participate. It is expected that approximately 40 institutes can also be provided for some 1800 college teachers, to whom only eight institutes are available this year.

Illinois Natural History Survey

The Illinois Natural History Survey this year completes its first century of biological research. The state agency, which has its principal offices and laboratories on the University of Illinois campus in Urbana, dates its origin from 30 June 1858, when the Illinois State Natural History Society was founded at Bloomington. In 1877, research activities of the society, which through much of its existence had received state support, were taken over by the newly organized Illinois State Laboratory of Natural History. In 1917, the laboratory was united with the State Entomologist's Office, established in 1867, to form the present Illinois Natural History Survey, a division of the State Department of Registration and Education.

In the past 100 years, staff members of the state agency have made many notable contributions to biological science, especially in research relating to the renewable natural resources of Illinois. They did pioneer research on animal ecology; the biology of the Illinois River prior to and during the development of the Chicago pollution problem; populations and food habits of fishes and birds; causes of the stunting of fishes in lakes and ponds; classification, life history, and control of important insects; resistance of insects to chemicals; and control of important plant diseases.

Early well-known biologists who had research papers published by the agency include Stephen Alfred Forbes, for 48 years its chief, whose *The Lake as a Microcosm* is a classic in ecology; David Starr Jordan, author of a catalog of Illinois fishes who became president of Stanford University; Robert Ridgway, Smithsonian ornithologist and author of two volumes on Illinois birds; and Charles A. Kofoid, author of several papers on plankton who joined the University of California at Berkeley.

Current research projects of the Illinois Natural History Survey staff include

control of the European corn borer through diseases and predatory insects; detection and measurement of insecticide residues on crop plants and in meat and milk; life history and distribution of leafhoppers and other important insects; antibiotics in control of tree diseases; toxicity of fluorines and other chemicals to fishes; population control of fishes in streams and small lakes; hybridization in fishes; and population dynamics and diseases of upland birds, migratory waterfowl, and wild mammals.

The Illinois Natural History Survey will issue later this year an extensive report on its first century of research. Authors of the report are Harlow B. Mills, present chief of the survey, and heads of the several research sections. Mills is widely known as an authority on the Collembola.

News Briefs

The Atomic Energy Commission has concluded on the basis of recent studies that there is little or no early economic promise for a small aqueous homogeneous nuclear power reactor similar to the demonstration reactor power plant proposed by the Wolverine Electric Cooperative of Big Rapids, Mich., and that it would therefore be in the best interests of the Government and of Wolverine to discontinue any further action with respect to the proposed project.

* * *

The U.S. Public Health Service has announced the availability of a schedule of laboratory refresher training courses that are to be offered by the Laboratory Branch of the Communicable Disease Center during the period 15 September 1958 to 10 April 1959. Information and application blanks may be obtained from the Laboratory Branch, Communicable Disease Center, U.S. Public Health Service, P.O. Box 185, Chamblee, Ga.

* * *

The Council for Old World Archaeology is now functioning. The council is an agency for service, not a learned society. Its immediate program is to publish for every part of the Old World a survey of current archeological activities and a current bibliography (selected and annotated). For information, write to the council at 11 Divinity Ave., Cambridge 38, Mass., U.S.A.

* * *

The following chemicals are wanted by the National Registry of Rare Chemicals, Armour Research Foundation of Illinois Institute of Technology, 13 W. 33rd St., Chicago 16, Ill.: 5-fluoronicotinamide; chloramide; cyclobutane; 3′,-3″,5′,5″-tetrabromophenolphthalein ethyl ester potassium salt; 1,1,1-trichloro-2-propanol (Isopral); 3-hydroxy-4-methoxycinnamic acid (Isoferulic acid); 2,3′-bipyridine; 5,5-dimethylcyclopentadiene; 1,1,3-trimethyl urea; N,N,N-trimethylborazole; 2,2′-thiobis(4-chloro-6-methyl phenol); 2-heptanol; 2,4,6,2′2″,4″-heptamethoxytriphenylcarbinol; nicotinaldehyde; 2-isocyanatopropane; 1-methylcyclobutene; tris(4-nitrophenyl)methane; N-(2-naphthyl)phosphoramidic acid; 6-hydroxy-2-methyl-4-pyrimidine ethanol; and β,β,β-trichloroborazole.

New Journals

Atompraxis, vol. 2, No. 4 (international monthly publication for research in the practical applications of atomic energy). E. H. Graul, Ed. Braun, Karlsruhe, Germany. $12.

Curator, vol. 1, No. 1, Jan. 1958. Edwin H. Colbert, Ed. American Museum of Natural History, New York 24. Quarterly. $5.

Daedalus, Winter 1958. Philip Reiff, Ed. American Academy of Arts and Sciences, Boston 46. Quarterly. $6.50.

Electronics Express, vol. 1, No. 0 (prepublication sample issue. First issue due 1 Apr.). International Physical Index, Inc., New York 35. 10 issues per year. $57.50.

Haematologica, vol. 1, No. 1, 1957. J. Aleksandrowica, Ed. III Klinika Chorób Wewnetrznych, Akademii Medycznej, Kraków 17, Poland.

Journal of the All India Institute of Mental Health, vol. 1, No. 1, Jan. 1958. M. V. Govindaswamy, Ed. All-Indian Institute of Mental Health, Bangalore 2, India. Biannual. Rs. 12.

Journal of the Malacological Society of Australia, No. 1, Sept. 1957. Malacological Society of Australia, Melbourne, Australia.

New Zealand Journal of Agricultural Research, vol. 1, No. 1, Feb. 1958. M. A. Black, Ed. New Zealand Department of Scientific and Industrial Research, Box 8018, Wellington, N.Z. Bimonthly. 30s.

Radiation Research Conference

The first International Congress of Radiation Research will be held at the University of Vermont in Burlington, 10–16 August, under the joint sponsorship of the National Academy of Sciences–National Research Council and the Radiation Research Society in cooperation with the European Committee on Radiobiology. Two aspects of the congress are of special interest: there will be unusual representation in that an estimated 90 percent of the world's leading specialists in radiation research will participate, and the scope of the conference will be exceptionally broad. Some 325 contributed papers will range in subject matter from general physics and information theory to the latest data on radiation effects in humans. In addition, 35 international authorities will discuss particular areas of investigation in a series of seven symposia scheduled concurrently with the sessions of contributed papers.

Among the speakers from abroad are: F. S. Dainton, University of Leeds; L. A. Stocken, Oxford University; L. Ehrenberg, University of Stockholm; R. H. Mole, Harwell, England; P. A. Giguere, Laval University, Quebec; J. Weiss, King's College, Newcastle; M. Magat, University of Paris; A. Comfort, University College, London; A. C. Stevenson, Queen's University of Belfast; A. P. James, A. E. Canada, Chalk River; J. A. V. Butler, Chester Beatty Institute, London; R. Latarjet, Inst. du Radium, Paris; G. Porter, University of Sheffield; and K. G. Zimmer, University of Heidelberg.

Scientists in the News

The board of directors of City Trusts, Philadelphia, has selected three British and two American scientists as winners of the 1958 John Scott awards for useful inventions. Recipients of the $1000 awards were BASIL A. ADAMS of Glamorganshire and ERIC HOLMES of Essex, England, chemists; A. J. P. MARTIN, biochemist at the National Institute of Medical Research in London; WISE BURROUGHS, professor of beef cattle production at Iowa State College; and RENATO DULBECCO, biochemist and professor at California Institute of Technology.

This year's honorary degree recipients include the following:

GERTRUDE M. COX, director of the Institute of Statistics, Consolidated University of North Carolina, and GEORGE W. SNEDECOR, visiting professor in the Institute of Statistics at North Carolina State College, from Iowa State College.

GRAHAM DuSHANE, editor of *Science,* from Wabash College.

CLIFFORD C. GREGG, director of the Chicago Natural History Museum, and RALPH E. DURY, director of the Cincinnati Museum of Natural History, from the University of Cincinnati.

SOLOMON C. HOLLISTER, dean of the engineering department at Cornell University, from Lehigh University.

ELMER HUTCHISSON, director of the American Institute of Physics, and NORMAN TAYLOR, retired curator of the Brooklyn Botanic Garden, from Washington College, Chestertown, Md.

LEONARD G. ROWNTREE, former chief of the division of medicine and

director of clinical research at the Mayo Clinic, from the University of Miami.

MARSH W. WHITE, professor of physics at Pennsylvania State University, from Park College, Parkville, Mo.

SIGURD HANSEN, state geologist of Denmark and a specialist in Pleistocene history, and RICHARD J. LOUGEE, professor of geomorphology at Clark University, will do field work in the United States and Canada during July and August on problems of trans-Atlantic Ice Age correlation. The program is sponsored jointly by the Danish Geological Survey and Clark University.

WILLIAM A. FEDER, plant pathologist, Agricultural Research Service, U.S. Department of Agriculture, Orlando, Fla., will be on leave at the Polytechnic Institute, London, England, beginning 10 September. He has received a senior postdoctoral fellowship to conduct research with C. L. Duddington in a study of certain nematode-inhabiting fungi.

JOHN E. CHRISTIAN, professor of pharmaceutical chemistry at the School of Pharmacy of Purdue University, has received the Rho Chi Citation Award in recognition of his many contributions in the field of pharmaceutical research.

WILLIAM A. POEL, research associate and head of the experimental carcinogenesis laboratory of the department of occupational health, Graduate School of Public Health, University of Pittsburgh, has been granted a year's leave of absence for advanced studies in animal pathology at the Roscoe B. Jackson Memorial Laboratory. The study is supported by a special fellowship of the National Cancer Institute, the first such to be awarded.

MORRIS ZIFF, formerly associate professor of medicine at New York University's College of Medicine, is head of the new arthritis unit at the University of Texas Southwestern Medical School in Dallas. Ziff is well known for work on the rheumatoid factor, a substance found in the blood of people suffering from rheumatoid arthritis.

MORRIS S. VITELES, professor of psychology at the University of Pennsylvania, was elected president of the International Association of Applied Psychology at a recent meeting of the association in Rome. Viteles is the first American to be elected to this office during the approximately 40 years of the association's history.

JOSEPH V. SWINTOSKY, a group leader in the pharmaceutical research section of Smith, Kline and French Laboratories, was awarded the Ebert Prize at the recent meeting of the American Pharmaceutical Association in Los Angeles, Calif. He was honored as author of the scientific paper that represented the best original research reported in any of the journals of the American Pharmaceutical Association during the preceding year. Swintosky's prize-winning research concerned sulfaethylthiadiazole.

WILLARD GAEDDERT, assistant professor of science at Mankato State College, Mankato, Minn., has been named professor of physics and chairman of the department at Park College, Parkville, Mo. He succeeds LAURENCE R. McANENY, who resigned to accept a position with Southern Illinois University in Alton, Ill.

DANIEL S. MARTIN, formerly with the department of surgery at the College of Physicians and Surgeons, Columbia University, has been appointed associate professor of surgery and director of the Surgical Research Laboratories at the School of Medicine, University of Miami.

W. A. PULVER has been named chief engineer of the Georgia Division of the Lockheed Aircraft Corporation. He succeeds R. W. MIDDLEWOOD, who has been named director of the newly formed Georgia Nuclear Laboratories. Pulver, who has been assistant chief engineer of the Georgia Division, joined Lockheed in 1936 at the Burbank facilities.

RICHARD S. MORSE, president of the National Research Corporation of Cambridge, Mass., is the new chairman of the Army Scientific Advisory Panel. He succeeds FREDERICK L. HOVDE, president of Purdue University. The panel is composed of 57 scientists, engineers, educators, and industrialists.

Recent Deaths

JACOB AUSLANDER, New York, N.Y.; 61; practicing physician and chief of the arthritis clinic at Sydenham Hospital; known for his work for broad social security and medical insurance coverage.

SAMUEL G. BARTON, Philadelphia, Pa.; 76; former associate professor of astronomy at the University of Pennsylvania and retired director of its Flower Observatory; specialist in the observation of double stars; 2 June.

TOWNSEND CROMWELL, Guadalajara, Mexico; physical oceanographer and senior scientist with the Inter-American Tropical Tuna Commission, San Diego, Calif.; research associate at the University of California's Scripps Institution of Oceanography; 2 June.

LEONARD R. INGERSOLL, Madison, Wis.; 77; emeritus professor of physics at the University of Wisconsin; specialist in optics and light; inventor of a Glarimeter for measuring the gloss of paper; 25 Apr.

ARTHUR KIRSCHBAUM, Houston, Tex.; 47; chairman of the department of anatomy at the Baylor University College of Medicine and cancer researcher; formerly taught at the University of Illinois, the University of Minnesota, and Yale University; 28 May.

BENZION LIBER, New York, N. Y.; 83; psychiatrist with the New York City Department of Welfare, emeritus professor of psychiatry at New York Polyclinic Medical School, and a director of the mental Hygiene Clinic of New York Polyclinic Hospital; author of several books, including *Your Mental Health*; 6 June.

JOHN M. NICKELSEN, Monroe, Mich.; 66; emeritus professor of mechanical engineering at the University of Michigan; chief consulting engineer for the Monroe Auto Equipment Co.; 3 June.

BERNARD S. OPPENHEIMER, New York, N.Y.; 81; cardiologist and emeritus clinical professor of medicine at the College of Physicians and Surgeons of Columbia University; 10 June.

ROBERT F. POOLE, Anderson, S.C.; 64; president of Clemson College for 18 years; former professor of plant pathology at North Carolina State College; 6 June.

HENRY W. SCHLENKER, Elizabeth, N.J.; 44; head of the analytical section of Reichhold Chemical, Inc.; 5 June.

BELL M. SHIMADA, Guadalajara, Mexico; fisheries biologist and senior scientist with the Inter-American Tropical Tuna Commission, San Diego, Calif.; research associate at the University of California's Scripps Institution of Oceanography; 2 June.

DAVID A. TUCKER, Cincinnati, Ohio; 67; medical historian and assistant to the dean of the College of Medicine of the University of Cincinnati; president of the Ohio Academy of Medical History, 1954–55; president of the Cincinnati Academy of Medicine, 1945–46; chairman of the admissions committee of the Cincinnati Medical School for more than 20 years; 3 June.

ALEXANDER N. WINCHELL, New Haven, Conn.; 84; mineralogist and petrologist; member of the faculty of the University of Wisconsin, 1907–44; visiting professor of mineralogy at the University of Virginia, 1948–49, and at Columbia University, 1949–50; 8 June.

Book Reviews

Darwin's Century. Loren Eiseley. Doubleday, New York, 1958. xvii + 378 pp. $5.

At the meeting of the Linnean Society in London on the evening of 1 July 1858, the secretary read communications from Charles Darwin and Alfred Russel Wallace that had been sent to him by Charles Lyell and Joseph Hooker. The theory of evolution through natural selection was born. Now, on the hundredth anniversary of that event, it is appropriate that scholars of all sorts should pause to assess the situation, to look at the genesis and at the consequences of that great shift in human thought that has aptly been called the Darwinian revolution.

July 1st, 1858, or November 24th, 1859—when the *Origin of Species* was published—are of course arbitrary moments in the history of a continuously developing idea. Charles Darwin was but one of many intellects who influenced the rate and direction of this development, though of such overwhelming influence that the 19th century, from the point of view of a broad segment of Western intellectual history, can well be called Darwin's century. In writing about Darwin's century, then, Loren Eiseley is writing about the history of an idea—the idea of evolution.

Eiseley shows a complete mastery of his materials, a detailed scholarship that leaves me tremendously impressed. But he does not get lost among these details; each is related to the broad sweep of his story. One is led, almost inevitably, to compare Eiseley's book with Arthur Lovejoy's *The Great Chain of Being*. Eiseley's book in a real sense is built on Lovejoy's book. Because of Lovejoy, Eiseley can begin his story with the 17th century; he can confidently discuss the relations between the idea of the chain of being and the idea of evolution without needing to explore the sources of modern thought in ancient or medieval times.

Eiseley is careful to point out the basic differences between the ideas of a chain of being and of evolution, and the comparison of the two books is not necessarily a consequence of relatedness of subject matter. The comparison comes to mind because both books stand out as superb jobs of blending scholarly detail into reasonable historical interpretation; the two books are, I think, comparable contributions to that most difficult of fields, the history of ideas—the field that on contemporary American campuses would, I suppose, be called the sociology of knowledge. And the similarity remains despite the great difference in the style of the two authors. Both, I think, are masters of English prose, but they have achieved their mastery after quite different fashions. Eiseley, I suspect, is far more readable than Lovejoy. I write this reluctantly, and I am not sure it is praise. The aptness of Eiseley's expression carries the reader through the parts of his story that have been told so often that they have become hackneyed, and the aptness of this expression often serves to put some well-known incident in a new light. But I don't think Eiseley has anywhere quite achieved the memorable dry, yet full-bodied, richness of, say, Lovejoy's discussion of "metaphysical pathos." But I am writing a review of Eiseley's book, not of Lovejoy's.

Perhaps the greatest achievement of Eiseley's book is in explaining lucidly why it took so long for the Copernican revolution, which put the earth into cosmic perspective, to develop into the Darwinian revolution, which put man into biological perspective. The ideas necessary for this transition, and the people who developed these ideas, are partly well known, partly obscure.

First, "an orderly and classified arrangement of life was an absolute necessity before the investigation of evolution, or even its recognition, could take place." The foundations here were laid by John Ray and, outstandingly, by Linnaeus. Eiseley aptly remarks that "Linnaeus shares, with the Comte de Buffon, the distinction of being a phenomenon rather than a man. This achievement, though it demands great energies and unusual ability, is, in reality, dependent upon the psychological attitudes of a given period." Eiseley gives both Linnaeus and Buffon considerable attention. Scattered through Buffon's writings can be found many intimations of an evolutionary theory—of the struggle for existence, of variation within species, of structural similarity among quite different animals, of uniformitarian geology and the vastness of past time, of the extinction of some past forms of life, of the significance of animal and plant distribution. But the knowledge of the time, and perhaps also Buffon's caution, did not permit these bits to be welded into a coherent theory.

A little later Erasmus Darwin and Jean Baptiste Lamarck did develop formal theories of evolution. The ideas of the two men were quite similar—very likely because both derived from Buffon—but neither was able to arrive at a plausible mechanism for evolutionary change. Lamarck, surely one of the great figures of biology, has suffered the curious fate of having his name, in the adjective form "Lamarckian," turned into a term of opprobrium. This is partly, at least, a consequence of the political circumstances of his time. As Eiseley points out, "the reaction, in England, to the French Revolution was destined to sweep Erasmus Darwin's ideas out of fashion, reinstitute a religious orthodoxy, and lead to the derogation of Lamarck as a 'French atheist' whose ideas were 'morally reprehensible.' In the end a conspiracy of silence surrounded his work. As has happened many times before in the history of thought, an idea has become the victim of social events and its re-emergence was to be delayed accordingly."

Before evolution could become a really pervasive idea, geological time had to be discovered and charted. Eiseley builds his discussion of the exploration of past time around three men: James Hutton, William Smith, and the Baron Cuvier. "If there is one mind," Eiseley remarks, "that deserves to rank between the great astronomical geniuses of the seventeenth century and Charles Darwin in the nineteenth, it is James Hutton." He discovered time, boundless and without end, "demonstrated by the very stones of the world, by the dust and clay over which the devout passed to their places of worship." He reaped the rewards of animus and heresy, of silence and disdain; his ideas were eclipsed for a while by the doctrines of catastrophic geology, until they emerged, triumphant, in the works of Charles Lyell.

William Smith, a practical engineer, discovered stratigraphy, discovered a way of charting time through the examination of fossils. Cuvier, the great anatomist, discovered how the structure of the living could be used to interpret the clues left from the past. "A bone, to Cuvier, was never just a bone, because it told, in its curvatures and varied processes, the story of an organized being whose every other bone and organ could be expected to be in harmonious proportion and accord with the solitary fragment."

Hutton, Smith, and Cuvier together "possessed the secret of the past but they never sat down in the same tavern to put the chart together." It was Charles Lyell who first wrote a coherent, general account of geology; and while Lyell did not develop a theory of evolution, Darwin's debt to him—evolution's debt to him—is enormous. "One can scarcely resist the observation that the *Origin* could almost literally have been written out of Lyell's book, once the guiding motif of natural selection had been conceived."

Eiseley discusses Darwin's predecessors in evolutionary theory—William Wells, Patrick Mathew, Robert Chambers. But the major portion of Eiseley's book, naturally, deals with Darwin himself: with his ideas and the sources of his ideas. There is probably more documentation on Darwin—more letters, notebooks, impressions, analyses—than on any other scientist. Yet he remains a baffling personality—difficult to understand, perhaps, because of the very extent of the documentation. The Darwin of the *Autobiography* and of the letters to close friends is, surely, the conscious Darwin, self-revealed. But thought does not reach its full development through conscious processes, and subconscious influences were surely just as important with Darwin as with any of us. Darwin's own concept of how he arrived at an idea is often clearly inadequate, which makes the game of trying to untangle the influences on his thinking even more fascinating. Eiseley makes many thoughtful contributions to this study.

Eiseley has a particularly interesting discussion of two attacks on Darwin that are now not well enough remembered. An erudite Scotch engineer, Fleeming Jenkin, published an article in 1867, pointing out in neat mathematical terms that a newly emergent character, however favorable, would, with blending inheritance, be swamped through backcrossing. The Mendelian answer to this had already been written but was unknown, and Darwin could find no answer. The other attack was from the physicists. Lord Kelvin, looking at the heat production of the sun in thermodynamic terms, found that the biologists and geologists could not possibly have the vast stretch of time that they needed for evolutionary processes. Again Darwin had no answer; there was no answer until the discovery of radioactivity at the end of the century. Darwin could only become more cautious, more Lamarckian, with each successive edition of the *Origin*.

Eiseley draws a moral from this. "Today there is a tendency in some quarters to regard the physical sciences as superior in reliability to those in which precise mathematical adeptness has not been achieved. Without wishing to challenge this point of view, it may still be worth a chastening thought that, in this long controversy extending well over half a century, the physicists made extended use of mathematical techniques and still were hopelessly and, it must be added, arrogantly wrong."

The last chapters of the book are appropriately devoted to the problems of human evolution: to the controversies over the first human fossils, to the divergence between Darwin and Wallace over the special case of man, to the emergence of the concept of culture and of cultural evolution. The book ends with the end of the century, with only occasional allusions to the vicissitudes of evolutionary ideas in the present century. Perhaps Eiseley will now carry the story on, in another book, to our own time. Whether he carries on or not, he has made an important contribution both to the history of ideas in general and to the history of evolution in particular, and through this, I think, a very real contribution to the study of the evolutionary process itself.

MARSTON BATES
Department of Zoology,
University of Michigan

Hospital Treatment of Alcoholism. A comparative experimental study. Menninger Clinic Monograph Series No. 11. Robert S. Wallerstein *et al.* Basic Books, New York, 1957. xi + 212 pp. $5.

The past few years have seen an encouraging rise in the number and quality of investigations of the goals, methods, and results of therapies for alcoholics. Since we are yet far from a satisfactory knowledge of the causes and dynamics of uncontrolled, pathological use of ethyl alcohol, it is clear that methods for rehabilitating alcoholic patients are properly approached from a research viewpoint. The clinical study by Wallerstein and his colleagues, reported in the present monograph, is a commendable and welcome example of this point of view.

What the authors have done is to compare four different methods used in treating a group of 178 alcoholic patients at Winter Veterans Administration Hospital from 1 Jan. 1950 to 30 June 1952 with a subsequent 2-year follow-up. The treatment modalities selected were (i) Antabuse (Disulfiram) therapy, (ii) conditioned-reflex therapy, (iii) group hypnotherapy, and (iv) "milieu" therapy (a control group). Of these modalities, it appeared that Antabuse therapy was most helpful to the most patients. However, of those to whom Antabuse was administered, nearly one-half were not helped. Also, it was concluded that the practical values of the other methods were sufficient to preclude the use of Antabuse as optimal for the mental hospital treatment of alcoholic patients.

In a study of which kinds of alcoholic patients tended to improve with which kinds of therapy, the authors found a significant correlation between *compulsivity* and improvement with Antabuse. The greater the characteristic *passivity* of the patient, the greater, in general, was his improvement under hypnotherapy. The danger of precipitating a psychotic reaction with Antabuse was stressed in borderline depressive or schizophrenic patients; these were helped more by the milieu therapy, which emphasized individual contact with the physicians and avoided threat to defense structure. Hypnosis seemed temporarily helpful to schizoid patients. Conditioned-reflex treatment seemed to evoke a good response in clinically depressed patients, but this treatment was considered contraindicated for masochistic individuals. With every type of therapy, those patients did best who were able to form and maintain close ties with the therapist, the hospital, and the program and, in general, to sustain relationships.

The authors have provided a sound analysis of their study, including analysis of the limitations of their project design (follow-up, patient selection, and so on), and have suggested lines of further investigation.

Karl Menninger's introduction to this monograph points out that enough correlation between the success of specific methods of treatment and the psychological characteristics of the patients has been revealed to merit further exploration of this idea. It is to be hoped that studies of this design will be widely extended.

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Integral Equations. F. G. Tricomi. Interscience, New York, 1957. viii + 238 pp. $7.

The subject matter of this book, as interpreted by the author, is a topic which has become a standard part of everyday analysis, to be used, in particular, in innumerable problems of applied mathematics. A few such problems are treated or alluded to, among them the critical speeds of a rotating shaft, the forced oscillations of finite amplitude for a pendulum, the airfoil equation, the vibrations of a membrane. The book is intentionally short, and yet it covers all the classical types; it presents as simply as possible the essentials of the theories of Volterra, Fredholm, Hilbert, Erhardt

Schmidt, Carleman, and Hammerstein. Standard real-variable tools, the Lebesque integral, the L_2 theory, orthonormal systems, and the transforms of Laplace, Fourier, and Mellin are used systematically but without ostentation, so as not to repel the physicist, engineer, or technician. Topological methods are not used. The style is attractive and is enlivened by some interesting personal comments (concerning Volterra, Fubini, and others).

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Light, Colour and Vision. Yves Le Grand. Translated by R. W. G. Hunt, J. W. T. Walsh, F. R. W. Hunt. Wiley, New York, 1957. xiii + 512 pp. $11.

The French original of this book, published in 1948, was the second of three volumes which serve as a textbook in the Institute of Optics in Paris. The first volume (of which there have been two editions) dealt with the geometrical optics of the naked and corrected eye—material which we have abundantly available already in English. The third volume, concerned with spatial vision from the point of view of a physicist, is not one for which an English version would be wanted.

This translation of volume 2 of *Optique Physiologique* is superlative. The translators, with help from the author and three other consultants, have updated the contents to create what amounts to a second edition. The extent of this amendation is indicated by the fact that there are about four times as many references as in the French original, although the text is no longer. The translators introduced only one important error ("wave-length" for "purity" in the caption of Fig. 74.)

The briefest statement of the coverage of the book would be that it deals with photometry and colorimetry: "The eye is a selective receptor, and the way it behaves under radiation is the subject of this volume." Physiological optics is commonly taught, in our schools of optometry and teaching departments of ophthalmology, with ophthalmic optics excluded and taken care of in a separate course. This book, even with its volume 3 appended, could not serve as a textbook in such places. This is sad, for a good, well-rounded textbook is badly needed. The present work is both too narrow and too deep, and too preoccupied with "mathematical" modes of expression, for broad use by American students. It is, however, very welcome indeed as an aid to the researcher in visual science in understanding those aspects of vision which Le Grand, a physicist with a deep interest in vision, is eminently equipped to elucidate.

The first three chapters deal with light and the measurement of visible radiation qua radiation, artificial sources (including the full radiator) and the sun, and the receptoral properties of the eye that make necessary a photometric system. The next three are concerned with photometry. Chapters 7, 8, and 9 cover (and deeply) colorimetry for "standard" and individual observers. This discussion is strung on the thread of the observed "trivariance" of vision, which is independent of all theory. Le Grand's only large blind spot shows up here (doing no practical harm): his curious inability to see that there is no connection whatever between two kinds of trivariance which he lumps together—the kind that requires a monochromatic colorimeter to have three controls and the kind that makes a tricolorimeter possible. The fact that a color sensation has a hue, a saturation, and a brightness is quite unrelated to the fact that mixtures of three primary color stimuli can afford all hues, and all saturations below their own. Le Grand also, perhaps without realizing it, puts complementation on a sensory basis, whereas it pertains strictly to stimuli. Colored *lights* can be mixed; but since their *colors* cannot be mixed, they cannot be said to neutralize each other. Otherwise, the "errors" in this first half of the book consist mostly of tiny sins of omission, together with unacceptable definitions of "simultaneous contrast" and "purple."

Chapters 10, 11, and 12, dealing with absolute and differential intensitive and chromatic thresholds, are particularly strong. Only slightly less satisfying are chapters 13 ("Time effects") and 14 ("Spatial interactions"). From there on the book tends to come apart.

Chapter 15, on the color blindnesses, is spoiled by the naïveté of the physicist and by ignorance of the implications of genetics for the interrelations of the defects. Chapter 16 commences section B, entitled "Theories of Vision"—although its first three chapters, on the anatomy, photochemistry, and electrophysiology of the retina, respectively, deal essentially with basic facts and belong earlier in the book. The reader will absorb so many little errors about the retina that he had best get his information elsewhere. The whole of chapter 17 is already antiquated. In chapter 18, the paucity of sensory correlates reveals the poverty of the whole field of retinal electrophysiology. There is not even any mention of the controversy over whether the electroretinogram is not entirely generated by stray light.

Chapter 19, on theories of color vision, very thoroughly expounds the situation of the Young-Helmholtz theory as of about a decade ago. All other theories are allotted only two pages, which is about what one expects from a physicist. In the final chapter (chapter 20, on threshold theory) the quantal and probabilistic elements are well developed, and Crozier's law is tactfully divorced from its original entanglement with "neural effect" and applied to things it may really describe.

There is a good index, a triple bibliography which "just grew," and a section of exercises (with solutions) which leads a teacher in one of our schools of optometry to envy the quality of student which the Institute of Optics is able to attract.

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Lectures on Nuclear Theory. C. Landau and Ya Smorodinsky. In English translation. Consultants Bureau, New York, 1958 (original text published by State Technical–Theoretical Literature Press, Moscow, 1955). 83 pp. $15.

This brief survey of nuclear physics is based on ten lectures given to experimentalists by Landau in Moscow in 1954. There appears to be little, if any, elaboration of the lectures' incisive, though necessarily fragmentary content. Numerous computations, none of them lengthy, are carried out, simplified frequently by approximate and intuitively reasonable arguments. The discussion, unhurried, is almost entirely self-contained. It assumes familiarity only with ordinary nonrelativistic quantum mechanics and, in lectures 7 and 10, with some thermodynamics and statistics. The presentation is rather consistently a statement of experimental results followed by theoretical analysis.

Lectures 1 to 3 are on nuclear forces. As an illustration, the first lecture starts by presenting the evidence for charge symmetry of nuclear forces, then discusses the deuteron bound state. Scattering of spinless particles is reviewed, phase shifts are introduced, and sign determination by Coulomb interference is mentioned. The general velocity-independent nucleon-nucleon interaction is developed, and tensor interaction is defined and its presence is inferred from the deuteron's quadrupole moment. Typical is the careful note, at the end of the first lecture, of the fact that for a loosely bound structure, such as the deuteron, even its small quadrupole moment requires a larger tensor interaction.

Nucleon-nucleon scattering at up to 20 Mev is discussed in lecture 2, and at

higher energies (up to 590 Mev) in lecture 3. The structure of light nuclei, in terms of the shell model, occupies lectures 4 and 5, and that of heavy nuclei, in terms of rotational states, is treated in 6. Lecture 7 is devoted to the statistical theory of nuclear reactions, and 8, to the optical model of (high-energy neutron) nuclear reactions and to deuteron reactions. Lecture 9, entitled "π-Mesons," deals largely with invariance principles, and 10 concludes the series with a discussion of pion-nucleon interactions and multiple meson production.

There is no index or bibliography, and references to the literature are rare. The format is agreeably uncrowded; the translation is clear and, although not entirely free of errors, is generally of good quality. It is unfortunate that this survey, which is of great value not primarily to the specialists but rather to graduate students, is priced prohibitively ($15 for 77 text pages) beyond their reach.

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Physico-Chemical Effects of Pressure. S. D. Hamann. Academic Press, New York; Butterworth, London, 1957. ix + 246 pp. Illus. $8.50.

The author states in the preface: "There are a number of books and reviews dealing with the physics of high pressures and there are several concerned with the practical use of pressure in the chemical industry, but it seems there has been no serious attempt to bridge the gap between physics and applied chemistry. The present book is intended to remedy this situation by presenting a survey of the effects of pressure in the field of physical chemistry." The author is well qualified by his experience to make this attempt, and it seems to me that he has been eminently successful.

There is and can be no sharp dividing line between physics and physical chemistry. Some of the topics treated here—for example, viscosity and optical absorption—have a strong physical component and are included here because certain of their aspects have, by tradition, been treated by physical chemists; this, in turn, is explained by the participation of these phenomena in topics of primary chemical interest. For example, viscosity is an important factor in determining the rate of many chemical reactions, and optical absorption can be used as a tool in determining the degree of progress of a reaction. The only topics not treated in this book to which a physicist might lay exclusive claim are electrical phenomena in metals—resistance and thermoelectricity and also various magnetic effects.

It appears that the primary and ultimate interest of the physical chemist is in reactions, and the discussion is, throughout, slanted in this direction. This discussion strikes me as most illuminating—the author has succeeded in directing attention to the underlying mechanisms in such a way as to give real understanding of many of the complicated effects of pressure on chemical equilibrium and kinetics and to give an insight into the most promising field for future exploration.

On one minor point I permit myself to disagree with the author. On page 62 he states that "first order transitions greatly outnumber second order transitions." It is my opinion that this is only apparently the case, and that when experimental accuracy has been sufficiently improved, second and higher order transitions will be found to greatly preponderate.

There is an impressive bibliography of 582 items. A hasty scanning of this bibliography leaves the impression that industry in England has been much more active in the investigation of high-pressure chemistry than industry in this country. This impression is by no means correct but is the result of a less liberal policy of publication in the United States. "Secrecy" was not invented in this country to protect our priority with the atomic bomb; the impulse to seek protection through secrecy is much older. It appears that this is, in a certain sense, a national trait.

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Infrared Absorption Spectra of Steroids. An atlas. vol. II. Glyn Roberts, Beatrice S. Gallagher, R. Norman Jones. Interscience, New York, 1958. viii + 95 pp. + charts No. 309 to 760. $20.

This volume from the National Research Council of Canada in Ottawa and the Sloan-Kettering Institute for Cancer Research in New York contains charts showing the infrared absorption spectra of 362 steroids, recorded on the same format as those reproduced in volume I [see *Science* **120**, 339 (1954)], and supplementary curves for 90 steroids described in volume I. The compounds examined include steroids needed to complete series of related isomers, new steroids of special clinical and biochemical importance, and a useful collection of D-homosteroids. With the exception of potassium bromide disc spectra for 50 less-soluble specimens, all the spectra are for solutions. The quality and standard of reproduction of the spectra are of the same high order as in volume I, but unfortunately no physical data that might indicate the purity of the samples examined are given.

The charts are preceded by a valuable introduction containing a section on the analysis and interpretation of steroid spectra, a set of 17 tables listing characteristic group frequencies for steroids, and a comprehensive bibliography. The tables are the most complete yet published and will be welcomed by all laboratories concerned with the isolation, synthesis, and structural identification of steroids and related substances.

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The Growth of Logical Thinking from Childhood to Adolescence. An essay on the construction of formal operational structures. Bärbel Inhelder and Jean Piaget. Translated by Anne Parsons and Stanley Milgram. Basic Books, New York, 1958. xxiv + 356 pp. $6.75.

Every parent who has attempted to fix the mind of a young child attentively upon an intellectual problem for more than ten seconds will read of the accomplishments of Bärbel Inhelder with mixed admiration and disbelief. Perhaps Swiss children are different, but it is more likely that Inhelder has a rare and sensitive skill for finding problems, devising situations, and asking questions that permit her young friends to show to best advantage. How else could she explore with children (ages 5 to 15) such problems as angles of incidence and reflection, density and specific gravity, flexibility of rods, the pendulum, falling bodies on inclined planes, effects of hidden magnets, chemical reactions, conservation of motion, hydraulic equilibria, the law of the balance, projection of shadows, centrifugal force, probability, and statistical correlation?

Inhelder's collaborator in this remarkable book is none other than Jean Piaget, the most imaginative and prolific child psychologist alive today. Piaget assumes the task of isolating and analyzing the formal or propositional structures underlying the children's attempts at understanding. Consequently, there are 15 chapters which conform to the same pattern: first, Inhelder's data; second, Piaget's analysis. The book ends with 100 pages on the structural integration of formal thought, where Piaget has a chance to develop his ideas more systematically.

The focus is on changes in the structure of thought processes which seem to occur at the age of 11 to 12 years. Much has been written about emotional adjustments necessary at this age, but cognitive changes have received far less attention. The authors argue that at this age a child becomes capable of certain *formal* or abstract operations of thought which before were possible only as *concrete* operations on properties of the immediately present object world. This provides the last of three mental revolutions during development: the first occurs at two years when sensorimotor schemata are supplemented by symbols for representing the environment; the second, at 7 to 8 years, when it becomes possible for the child to foresee the results of concrete operations. Thus the present book takes its place in the larger design of Piaget's description of mental development.

The reader can be grateful to Anne Parsons and Stanley Milgram for an excellent translation and for a brief, helpful introduction to Piaget's psychology.

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New Books

Earth's Shifting Crust. A key to some basic problems of earth science. Charles H. Hapgood. Pantheon Books, New York, 1958. 438 pp. $6.50.

A List of Zoological and Botanical Types Preserved in Collections in Southern and East Africa. vol. I, pt. 1, *Zoology.* South African Council for Scientific and Industrial Research, Pretoria, South Africa, 1958. 147 pp. Paper, 7s. 6d.

Physics and Philosophy. The revolution in modern science. Werner Heisenberg. Harper, New York, 1958. 221 pp. $4.

Anatomist at Large. An autobiography and selected essays. George W. Corner. Basic Books, New York, 1958. 220 pp. $4.

Human Infertility. C. Lee Buxton and Anna L. Southam. Harper, New York, 1958. 239 pp. $7.50.

Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death. Based on the recommendations of the seventh revision conference, 1955, and adopted by the ninth WHO Assembly under the WHO nomenclature regulations. vol. 1. World Health Organization, Geneva, 1957 (order from Columbia Univ. Press, New York). 444 pp. $6.75 (price includes vol. 2, in press).

The UFAW Handbook on the Care and Management of Laboratory Animals. Alastair N. Worden and W. Lane-Petters. Universities Federation for Animal Welfare, London, ed. 2, 1957. 951 pp. 70s.

Splitting of Terms in Crystals. Hans A. Bethe. Consultants Bureau, New York, 1958 (English translation from *Annalen der Physik,* vol. 3, pp. 133–206, 1929). 69 pp. $3.

Minerals, Metals and Gems. A. Hyatt Verrill. Grosset & Dunlap, New York. (c. 1939) 302 pp. $1.98.

Principles of Biology. W. Gordon Whaley, Osmond P. Breland, Charles Heimsch, Austin Phelps, A. R. Schrank *et al.* Harper, New York, ed. 2, 1958. 887 pp. $6.75.

X-Rays and the Electric Conductivity of Gases. Comprising papers by W. C. Rontgen, J. J. Thomson, E. Rutherford; historical introduction by N. Feather. Alembic Club Reprints, No. 22. Livingstone, Edinburgh, 1958. 73 pp. Paper, 6s. 6d.

Determinism and Freedom in the Age of Modern Science. A philosophical symposium. Sidney Hook, Ed. New York Univ. Press, New York, 1958. 242 pp. $5.

The Encylopaedia of Radio and Television. A complete alphabetical reference to all aspects of modern radio technology. Philosophical Library, New York, ed. 2, 1958. 736 pp. $12.

The Strange Story of Our Earth. A. Hyatt Verrill. Grossett & Dunlap, New York, 1958. 267 pp. $1.98.

Group Processes. Transactions of the Third Conference, 7–10 Oct. 1956, Princeton, N.J. Bertram Schaffner, Ed. Josiah Macy, Jr. Foundation, New York, 1958. 328 pp. $4.

The Testing of Negro Intelligence. Audrey M. Shuey. J. B. Bell, Lynchburg, Va., 1958. 366 pp. $4.

Differential Psychology. Individual and group differences in behavior. Anne Anastasi. Macmillan, New York, ed. 3, 1958. 676 pp. $7.50.

Analysis and Control of Nonlinear Systems. Nonlinear vibrations and oscillations in physical systems. Y. H. Ku. Ronald, New York, 1958. 367 pp. $10.

Advances in Geophysics. vol. 4. H. E. Landsberg and J. Van Mieghem, Eds. Academic Press, New York, 1958. 466 pp. $12.

Reprints

A Short History of Anatomy from the Greeks to Harvey. Charles Singer. Dover, New York, 1957 (originally published as *The Evolution of Anatomy,* 1925). 221 pp. Paper, $1.75.

The Theory of Functions of a Real Variable and the Theory of Fourier's Series. vols. I and II. E. W. Hobson. Dover, New York, 1958 (republication of vol. 1, ed. 3, 1927 and vol. 2, ed. 2, 1926). 736 pp.; 780 pp. $3 per volume.

Thermodynamics. Enrico Fermi. Dover, New York, 1958 (republication of ed. 1, 1937). 160 pp. $1.75.

Foundations of Physics. Robert Bruce Lindsay and Henry Margenau. Dover, New York, 1958 (republication of ed. 1, 1936). 542 pp. $2.45.

Elements of Mathematical Biology. Alfred J. Lotka. Dover, New York, 1958 (formerly published as *Elements of Physical Biology*). 465 pp. $2.45.

A Treatise on the Analytic Geometry of Three Dimensions. George Salmon. Revised by Reginald A. P. Rogers. Charles H. Rowe, Ed. Chelsea, New York, ed. 7, 1927. $4.95.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, but to the publisher or agency sponsoring the publication.)

Zoological Society of India, Year-Book. (1 Apr. 1956 to 31 Mar. 1957). Zoological Soc. of India, c/o Zoological Survey of India, 34, Chittaranjan Ave., Calcutta-12, India, 1957. 48 pp. Rs. 2.

On the Paragenesis of Copper Ores. Studia Universitatis Lovanium, Faculté des Sciences, 4. Paul Bartholomé. Editions de l'Université, Leopoldville, Congo Belge, 1958. 31 pp.

Gallionella Ferruginea Ehrenberg in a Different Light. Verhandelingen der Koninklijke Nederlandse Akademie Van Wetenschappen, Afd. Natuurkunde, LII, No. 2. W. Van Iterson. Noord-Hollandsche, Amsterdam, 1958. Fl. 15.

Status Reports on Optical Observations of Satellites 1958 Alpha and 1958 Beta. Spec. Rept. No. 11, IGY Project No. 30.10. Astrophysical Observatory, Smithsonian Institution, Cambridge, Mass., 1958. 41 pp.

Forest Research in India, 1954–55. pt. II, *Reports from Burma and Indian States.* Forest Research Inst. and Colleges, Dehar Run, India, 1957. 186 pp. Rs. 4.12.

Modern Yucatecan Maya Pottery Making. vol. xxiii, No. 4, pt. 2 of *Amer. Antiq.* Raymond H. Thompson. Society for American Archaeology, Salt Lake City, Utah, 1958. 157 pp. $2.50.

Handbook of Citrus Diseases in Florida. Bull. 587. L. C. Knorr, R. F. Suit, E. P. DuCharme. Univ. of Florida, Agricultural Experiment Stations, Gainesville, 1958. 157 pp.

Grain Research Laboratory, 1957 Report. J. Ansel Anderson. Board of Grain Commissioners for Canada, Winnipeg, Manitoba, 1958. 76 pp.

Survey of Research Projects in the Field of Aviation Safety. 1958 annual supplement. Daniel & Florence Guggenheim Aviation Safety Center at Cornell University, 468 Fourth Ave., New York. 18 pp.

Copying. Kodak data book. Eastman Kodak, Rochester, N.Y., ed. 6, 1958. 48 pp. $0.50.

Ruwenzori Expedition, 1952. vol. 1, No. 1, *Introduction with List of Localities,* G. O. Evans and D. S. Fletcher; Nos. 2–3, *Arctiidae (except Nolinae), Thyretidae and Notodontidae,* S. G. Kiriakoff; No. 4, *Arctiidae, Nolinae,* D. S. Fletcher; No. 5, *Lymantriidae,* C. L. Collenette; No. 6, *Geometridae,* D. S. Fletcher. British Museum (Natural History) London, 1958. 183 pp.

British Mosquitoes and Their Control. Economic Ser. No. 4A. British Museum (Natural History), London, ed. 4, 1958. 23 pp. 1s.

Checklist of the Freshwater Fishes of Canada and Alaska. W. B. Scott. Royal Ontario Museum, Division of Zoology and Palaeontology, Ontario, Canada, 1958. 30 pp. $0.35.

National Advisory Committee on Research in the Geological Sciences, Seventh Annual Report. 1956–57. Geological Survey of Canada, Ottawa, 1957. 165 pp. $0.50.

Reports

Avoidance "Conditioning" in Paramecia

Learning is usually assumed to be a property of multicellular organisms with central neural axes (beginning, in phylogeny, with the flatworm). However, Gelber (*1*) has reported that the one-celled paramecium can be "trained" to approach a platinum wire that has been associated with food. Jensen (*2*), on the other hand, concludes that the behavior in question may be explained in terms of uncontrolled changes in the water medium in which the paramecia are observed. The question at issue, therefore, is whether it is the paramecium or its environment that has been "conditioned."

The same issue was involved in a series of studies conducted in the 1930's on the ability of paramecia to benefit from experience in what might be termed an avoidance conditioning experiment. Bramstedt (*3*) studied paramecia in a half-light, half-dark, water-filled well. When the lighted half was heated and the dark half was cooled by external means, the paramecia tended to remain in the cool side. When the temperature of the two halves of the well was equalized, the animals continued to avoid the lighted, previously heated side. Bramstedt thus claimed to have demonstrated conditioning of the avoiding response to the stimulus of light, which does not ordinarily elicit this response. Grabowski (*4*), who repeated and extended Bramstedt's work, ran tests of animals under three conditions: a control for differential response to light, the light-heat "conditioning" situation, and a control for heat-induced changes in the water medium. Like Bramstedt, he reported light alone an ineffective stimulus to elicit avoidance. During "conditioning," Grabowski's animals avoided light when it was paired with heat and, for almost an hour after temperature equalization, spent considerably more time in the dark. In the heat-induced–change control condition, however, water which had been "conditioned" before the introduction of animals produced the same effect—paramecia avoided the previously heated side, although they had had no opportunity to form an association between light and heat. On the basis of the latter finding, Grabowski concluded that the "conditioning" in paramecia was an artifact of the technique: Paramecia avoided the previously heated side because it had a lower concentration of oxygen.

The investigation (*5*) described in this report was designed to provide other controls indicated in the Bramstedt-Grabowksi experiments which would aid in specifying the conditions under which the behavioral modification occurs. The first stage of this investigation was the replication of the three sets of experimental conditions described by Grabowski.

Thirty-four *Paramecium aurelia* (see Table 1) were observed individually in a half-lighted, half-darkened well-slide containing a well 17 mm in diameter by 3 mm in depth. The medium in which the animals were observed consisted of filtered wheat infusion. Six animals (light-control group) were observed for 10 minutes in the unheated infusion-filled well as controls for a differential response to light; 14 ("conditioning" group) were observed for at least 15 minutes after they had been subjected to a "conditioning" period of at least 40 minutes during which the lighted half of the well was heated and the darkened half was cooled from below, a gradient of from 80° to 105°F across the well being thus provided; 14 (O_2 control group) were observed for at least 15 minutes after they had been placed in an infusion-filled well in which the lighted half had previously been heated and the darkened half had been cooled for at least 40 minutes. The latter animals were placed in the well immediately after equalization of the temperature. The scores for several animals which remained motionless for all or most of the observation period have not been included.

During the "conditioning" procedure, all of the 14 animals avoided the heated side of the well, spending an average of only 2 minutes, 52 seconds (the range was from 1 minute, 9 seconds to 4 minutes, 39 seconds) out of the at least 40 minute "conditioning" period in the heated side. The average number of entrances into the heated side was 19.5 (range 8 to 40). Table 1 presents the mean proportion of time spent in the lighted side of the well by the animals in the various conditions. The mean proportions of time spent in the light by Grabowski's animals under similar conditions (calculated from Grabowski's data) are included for purposes of comparison. The data for the light-control group in each case are based on 10 minutes of observation; all other proportions are based on 15 minutes of observation. Table 2 presents the results of a weighted-mean-square analysis of variance (*6*) of the data of our study and of that of Grabowski.

The analysis of variance indicated that there was significant variance between experiments, between conditions, and, due to the interaction, between experiments and conditions (all at $p < .001$). The Dunnett t test (*7*) was used to make comparisons between the "conditioning" mean of our experiment and the other means. Neither of the control means of our experiment nor the light-control mean in Grabowski's experiment differed significantly from the "conditioning" mean in our experiment. The Scheffé test (*8*) was used for comparisons between means not involving the "conditioning" mean of our experiment. Although the

Table 1. Mean proportions of time spent in the light by *Paramecium aurelia* in the several conditions of the experiment discussed in this report and of that of Grabowski.

Item	Experimental group		
	Light control	O_2 control	"Conditioning"
	Katz and Mirsky		
Time in light (%)	0.47	0.45	0.40
N	6	14	14
	Grabowski		
Time in light (%)	0.46	0.14	0.10
N	19	4	8

Table 2. Analysis of variance of the data of the experiment discussed in this report and of that of Grabowski.

Source of variance	*df*	Mean square	*F*
Between experiments	1	0.5292	70.56*
Between conditions	2	0.2414	32.19*
Interaction of experiments × conditions	2	0.1227	16.36*
Error	59	0.0075	
Total	64		

* $p < .001$.

All technical papers are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).

light-control means of the two experiments do not differ, both the "conditioning" mean and the O_2 control mean in the Grabowski experiment are significantly lower ($p < .01$) than the corresponding means of our experiment. Although there was no significant difference between the O_2 control and the conditioning mean in the Grabowski experiment, both of these differed significantly ($p < .01$) from the light-control mean.

These comparisons demonstrate clearly that it was not possible to replicate the findings of Grabowski, except with respect to the proportion of time spent by the paramecia in the light in the light-control condition. Contrary to the results of Grabowski, neither conditioning the paramecia nor conditioning the water in our experiment produced any modification in the tendency of the animals to spend roughly equal amounts of time in the dark and light.

Some incidental observations made during the "conditioning" procedure may help to account for the difference in results. When the well was being differentially heated and cooled, a powerful convection current invariably accompanied the gradient in temperature—a current so powerful, in fact, that it often appeared to sweep an animal into the heated side of the well. The presence of the convection current under the conditions of our experiment would seem to rule out the possibility of there being an appreciable difference in oxygen concentration between the two sides of the 17 mm well in either the "conditioning" or the light-control situations. This is consistent with the finding of no significant difference among conditions in our experiment. If it is assumed that Grabowski was somehow able to avoid the presence of the convection current in his smaller 10 mm well (he makes no mention of convection), then the results of our study may be interpreted as supporting Grabowski's interpretation of the response modification of the paramecium in terms of environmental modification.

The results of our study and of those of Grabowski and of Jensen indicate that there has been no unequivocal demonstration of conditioning in paramecia, in either the food-approach or the heat-avoidance situations. Apparently, whenever the "learning" situation has been arranged so as to preclude the possibility of permanent or relatively permanent changes in the environment of the paramecium, then subsequent behavioral modifications have not been observed.

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References and Notes

1. B. Gelber, *J. Comp. and Physiol. Psychol.* **45**, 58 (1952); *Science* **126**, 1340 (1957).
2. D. D. Jensen, *Science* **125**, 191 (1957); **126**, 1341 (1957).
3. F. Bramstedt, *Z. vergleich. Physiol.* **22**, 490 (1935); *Zool. Anz. Suppl.* **12**, 111 (1939).
4. U. Grabowski, *Z. Tierpsychol.* **2**, 265 (1939).
5. This investigation was conducted at the City College of the College of the City of New York. We thank Professors J. E. Barmack and H. G. Birch for their guidance and suggestions and Samuel Greenhouse, National Institute of Mental Health, for advice on the statistical treatment of the data.
6. G. W. Snedecor, *Statistical Methods* (Iowa State College Press, Ames, 1946), p. 299.
7. C. W. Dunnett, *J. Am. Statist. Assoc.* **50**, 1096 (1955).
8. H. Scheffé, *Biometrika* **40**, 87 (1953).

7 February 1958

Fall of the Sputnik I Rocket

There has been considerable interest in the matter of determining the probable point of impact of artificial satellites (*1*). We are conducting a study of the behavior of satellites as they reenter the atmosphere during the final phase of their lifetimes, and in this connection we have examined the data on satellite 1957 Alpha 1, the carrier rocket which accompanied Sputnik I.

Our calculations lead us to the conclusion that 1957 Alpha 1 fell on 1 December 1957 at 0846 G.M.T., approximately 8 hours after the last radar observation made on it in the United States. We place the probable point of impact at latitude 45°N, longitude 106°E, in Outer Mongolia. The result of our investigation is shown in Fig. 1, which represents the trajectory of 1957 Alpha 1 during its final pass over the Northern Hemisphere. The probable impact point is marked by a circle in Fig. 1, and the uncertainty in the impact point by heavy lines to either side of this circle.

The analysis is based on several observations of the altitude of the satellite during the last five days of its lifetime. These altitudes were deduced from radar observations of 1957 Alpha 1 obtained by: (i) the Lincoln Laboratory (*2*) on 27 November at 2153 G.M.T., 29 November at 2137 G.M.T., and 30 November at 1944 G.M.T. and 2114 G.M.T.; (ii) the Stanford Research Institute (*3*) on 1 December at 0011 G.M.T.; and (iii) the staff of the Royal Radar Establishment (RRE) (*4*) at Malvern, England, on 1 December at 0828 G.M.T.

The altitudes obtained from these radar sightings are indicated in Fig. 2. Figure 2 also shows the calculated altitudes, determined by us from a numerical integration of the satellite equations of motion, starting with orbital data provided by the Smithsonian Astrophysical Observatory for the date of 11 November 1957. The calculated altitudes in Fig. 2 are seen to be in good agreement with the observed altitudes for all passes.

The penultimate measurement shown in Fig. 2 was taken on the Stanford radar during the final pass of the satellite over the United States. The last datum in Fig. 2 is that of the RRE radar at Malvern, obtained, as already noted, at 0828 G.M.T. It is interesting to note that even if both of these data are omitted, the comparison of the remaining observations with our calculated altitudes indicates that the satellite could not have fallen during its last pass over the continental United States, nor in fact for several passes thereafter. For if we assume the last pass in the lifetime of the satellite to be that in which it crossed the western United States, the calculated altitudes then fall on the dashed curve of Fig. 2. The differences between this curve and the data are well outside the probable errors for the observations. In our view, Fig. 2 provides conclusive evidence that the satellite continued on for approximately 8 hours beyond the pass over the west coast of the United States.

The last datum point in Fig. 2 is an altitude of 71 miles, obtained by the RRE radar. This observation is critical for the unambiguous determination of the impact point. An altitude as low as 71 miles indicates that at the time of the passage over Malvern the rocket had entered on the final dive of its reentry into the atmosphere. The detailed numerical integrations then indicate that the rocket continued on past Malvern for 64° in the plane of the orbit before striking the earth. This figure of 64° is subject to an uncertainty of ±15°, corresponding to the probable error in the altitude of the RRE observations, and

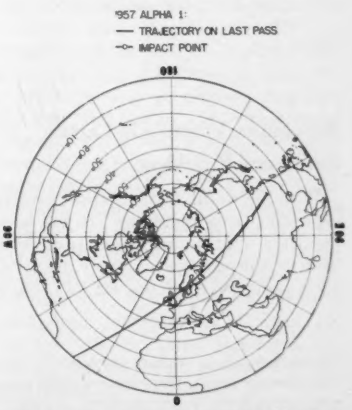

Fig. 1. Polar projection of the Northern Hemisphere showing the trajectory of satellite 1957 Alpha 1 during its final pass. The calculated impact point is indicated by a circle at latitude 45°N, longitude 106°E. The probable error in the impact point due to uncertainties in (i) the altitude over Malvern, England, and (ii) the drag coefficient is indicated with heavy lines to either side of this circle.

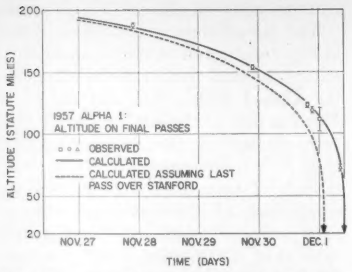

Fig. 2. Comparison of observed and calculated altitudes during the final days of satellite 1957 Alpha 1: ○, Lincoln Laboratory; □, Stanford Research Institute; △, Royal Radar Establishment (Malvern, England). The solid curve indicates the calculated altitudes. The dashed curve represents the calculated altitudes on the assumption that the satellite fell during its last pass over the United States.

to an uncertainty of ± 15°, corresponding to an assumed variation in the drag coefficient by a factor of 2. The combined uncertainty is shown by the heavy line in Fig. 1, as mentioned above.

In the final phase of the reentry the rocket probably disintegrated into elements of differing drag coefficient, whose impacts would be strewn over an arc length of the satellite trajectory approximately equal to the uncertainty in impact shown in Fig. 1.

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References and Notes

1. See *Science* 126, 1334 (27 Dec. 1957).
2. G. H. Pettengill, private communication.
3. A. M. Peterson and W. E. Jaye, private communication.
4. J. S. Hey and V. A. Hughes, private communication.

11 June 1958

B-Complex Vitamins in Certain Brown and Red Algae

With the world population continually expanding at a rapid rate, it has been predicted that future generations may have to depend more and more, for food, upon products from the sea (*1*). Such products include the algae, which are found in great abundance in many areas and about the nutritional value of which with respect to B vitamins, except for a small number of reports on some of the water-soluble factors in certain species (*2*) comparatively little is known. In this report (*3*) are presented the results of an investigation of the B-vitamin content of certain red and brown algae.

The plants analyzed were *Fucus spiralis, Ascophyllum nodosum, Laminaria agardhi,* and *Chondrus crispus.* They were taken from the coast line of New Hampshire and of York, Maine, through the months of October and November 1956. The algae were dried in a large, forced-hot-air dryer, at not over 85°C, and were then ground in a Wiley mill before analysis.

Analyses for the various vitamins were carried out by microbiological procedures (*4*); *Lactobacillus arabinosus* 17-5 (ATCC 8014) was used for niacin, pantothenic acid, and biotin; *Lactobacillus casei* (ATCC 7469), for riboflavin; *Streptococcus fecalis* (ATCC 8043), for folic acid; *Lactobacillus fermenti* 36 (ATCC 9833), for thiamine; and *Lactobacillus leichmannii* (ATCC 7830), for vitamin B_{12}.

The average results of the vitamin-content analyses are presented in Table 1. The four algae gave rather high results for niacin content when compared to many vegetables, fruits, and animal feeds. However, even the species containing the greatest amount of niacin, *Chondrus crispus,* contains considerably less than the 60 or more micrograms per gram found in barley and wheat. It can be concluded that these algae are a moderately good source of niacin. While all four of the algae studied are rich sources of pantothenic acid, the red alga *C. crispus* contains much more of the vitamin than do the three brown algae. This same relationship holds also for riboflavin and, to a lesser extent, for thiamine and vitamin B_{12}, indicating perhaps that in general the red algae are superior to the brown as a source of B vitamins.

In addition to being a good source of niacin and pantothenic acid, the algae are apparently a relatively good source of riboflavin and folic acid and a fair source of biotin and vitamin B_{12}. They are comparable with many fruits and vegetables as a source of thiamine.

It may be concluded, therefore, that the algae constitute an important potential source of certain water-soluble vitamins for animal, or human, consumption. Of the species studied, this is particularly true for the red alga *Chondrus crispus.*

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Table 1. Average vitamin content (in micrograms per gram) of various species of algae. The average results were figured from three to seven determinations.

Vitamin	*Fucus spiralis*	*Ascophyllum nodosum*	*Laminaria agardhi*	*Chondrus crispus*
Niacin	22.8	14.6	30.2	31.8
Pantothenic acid	23.0	49.4	33.0	150.0
Biotin	0.063	0.021	0.042	0.032
Riboflavin	10.0	3.50	12.6	25.0
Folic acid	1.91	1.50	10.00	9.50
Thiamine	0.40	0.23	0.46	0.83
Vitamin B_{12}	0.080	0.096	0.052	0.312

References and Notes

1. H. G. Mautner, *Econ. Botany* 8, 174 (1954).
2. G. E. Fogg, *The Metabolism of Algae* (Wiley, New York, 1953); Y. Ishihara, S. Umemoto, Y. Matsubara, *Hokkaidô Daigaku Nôgakubu Kiyô* 1, 83 (1951); M. Tsujimura, K. Tabei, T. Wada, *Nippon Nôgei-kagaku Kaishi* 26, 11 (1952); L. E. Ericson *et al., Arkiv Kemi* 6, 427, 511 (1953); L. E. Ericson and Z. G. Banhidi, *Acta Chem. Scand.* 7, 167 (1953); B. A. Southcott and H. L. A. Tarr, *Fisheries Research Board Can. Progr. Repts. Pacific Coast Stas. No. 95* (1953), p. 45.
3. This report is published with the approval of the director of the New Hampshire Agricultural Experiment Station as scientific contribution No. 219.
4. E. C. Barton-Wright, *The Microbiological Assay of the Vitamin B Complex and Amino Acids* (Pitman, New York, 1952); *Difco Manual for Microbiological and Clinical Laboratory Procedures* (Difco Laboratories, Detroit, Mich., ed. 9, 1953).

10 February 1958

Chemical Induction of Male Sterility in Inbred Maize by Use of Gibberellins

The effects of gibberellin on flowering of inbred maize were studied during the winter of 1957. Unexpectedly, plants sprayed with relatively high concentrations (500 to 1000 parts per million) of gibberellic acid developed sterile or partially sterile tassels. Possibilities of chemical induction of male sterility in maize by means of gibberellin were thus suggested.

The following summer this phenomenon was further investigated under field conditions. A relatively early-flowering inbred line, R53, was planted on 1 June and 1 July, and a relatively late-flowering inbred line, OH51, was planted on 1 June and 8 July. Potassium gibberellate (*1*) in concentrations of 100, 1000, 2000, and 2500 parts per million, and a wetting agent (Tween 20 at 0.1 percent) were used as a foliar spray. The estimated amount of gibberellin per plant ranged from 1.0 to 10 mg for the 1 June plantings and from 12 to 35 mg for the two later plantings. Approximately 40, 55, and 90 plants per treatment were sprayed and scored for the 1 June, 8 July, and 1 July plantings, respectively.

The critical stage of plant development for the most effective chemical induction of male sterility appeared to be when the immature male inflorescence (immature tassel) was approximately 1 in. in length. Plants were defoliated (with

a razor blade) to expose the immature tassel for measurement. Test plants from each planting were used to estimate the stage of plant maturity for the remaining plants.

Gibberellin-induced male sterility, ranging from tassels barren of all floral parts to tassels which approached normal pollen shedding, was found. Most sterile tassels developed all floral parts except stamens (pollen and pollen sacs). On partially fertile tassels the upper portion of the central spike or the terminal portions of the lateral spikes, or both, developed staminate spikelets and shed pollen. The number of anthers extruding from staminate spikelets during flowering was recorded as trace, light, moderate, and normal as a measure of relative fertility of the tassel. Silks were functional, and open-pollinated seed from male-sterile plants produced plants with fertile staminate flowers.

The early flowering line planted 1 June showed no gibberellin-induced male sterility in any of the treatments, and the data are not presented. The immature tassels of this earlier flowering line, being considerably more than 1 in. in length when treated, had apparently passed the stage of development for chemical induction of male sterility.

Data from field experiments are presented in Table 1. The late-flowering line planted 1 June showed sterility in varying percentages of tassels, depending on the time of application and the concentration of gibberellin applied. Application of both concentrations (500 and 1000 parts per million) of gibberellin 56 days after planting induced fewer sterile tassels on the main stalk, but it was observed that there were more sterile tassels on the "suckers" (lateral shoots) than when the same concentrations were applied 48 days after planting. Data for the "suckers" are not included in the percentages in Table 1. Gibberellin in concentrations of 100 parts per million at both times of spraying induced only an occasional partially sterile tassel, and no data were recorded.

Applying the gibberellin near the suggested critical stage of plant development and increasing the concentration of gibberellin 2½ times induced male sterility in the early flowering line planted 1 July. Both treatments resulted in sterility in 87 percent of the tassels. Similar treatments on the late flowering line in the 8 July planting induced sterility in 100 percent of the tassels.

In the two later plantings, flowering occurred in early September, when temperature and day length were less favorable for optimum pollen development and shedding. It is impossible to separate environmental effects present during the late plantings from the effect of increased concentrations.

Moore (*2*) and Naylor (*3*) reported chemical induction of male sterility when young maize plants were sprayed with maleic hydrazide. Wittwer (*4*) used maleic hydrazide effectively to induce male sterility in cucurbits. In this study, gibberellin effectively induced male sterility in two maize inbreds. This effect has not been reported in previous papers on gibberellin-treated maize.

Further investigations are needed to determine the reliability of this chemical (gibberellin) "sterilization" and its large-scale application in the production of maize hybrids. If consistently effective, chemical induction of male sterility would be a valuable method for reducing or eliminating detasseling of seed fields. (*5*)

Table 1. Chemical induction of male sterility in two inbred lines of maize by foliar applications of gibberellin.

Time of spraying (days after planting)	Gibberellin (ppm)	Male sterile tassels (%)	Partially fertile tassels			Normal tassels (%)
			Trace†	Light‡	Moderate§	
Late flowering line planted 1 June						
	0	0	0	0	0	100
48*	500	32	13	32	23	0
48*	1000	46	18	15	21	0
56	500	15	10	20	10	45
56	1000	25	3	7	15	50
Early flowering line planted 1 July						
	0	0	0	0	0	100
39* and 46	1000 each	87	5	6	2	0
39*	2500	87	10	3	0	0
Late flowering line planted 8 July						
	0	0	0	0	0	100
36* and 43	1000 each	100	0	0	0	0
36*	2000	100	0	0	0	0
43	1000	33	13	35	19	0

* Immature tassels were approximately 1 in. in length.
† Trace: from one extruded anther to 1 in. of extruded anthers on any part of the central spike or one lateral spike.
‡ Light: more than 1 in. of extruded anthers on any part of the central spike or one lateral spike, or a trace on two or more spikes, central or lateral.
§ Moderate: more than 1 in. of extruded anthers on two or more spikes, central or lateral.

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References and Notes

1. Potassium gibberellate was supplied by Merck & Co., Inc., Research Laboratories, Rahway, N.J.
2. R. H. Moore, *Science* 112, 52 (1950).
3. A. W. Naylor, *Proc. Natl. Acad. Sci. U.S.* 36, 230 (1950).
4. S. H. Wittwer, *Science* 120, 893 (1954).
5. The suggestions and advice of Dr. S. H. Wittwer in connection with this study are appreciated.

27 December 1957

Electrophoresis of Free Sugars in Blood

A convenient method, described in this report, for the qualitative identification of free sugars in blood provides a useful complement to data obtained from nonspecific oxidation methods. Thus, in the development of a micromethod for the quantitative determination of galactose, in which a Somogyi oxidant was used (*1*), definite confirmation of the presence of galactose was required as proof that the reduction was not due to other sugars or to nonsugar reducing substances.

A method for determining this, based on the electrophoretic behavior of the sugar-borate complexes (*2, 3*), is easy to perform and is more rapid than chromatographic methods. In developing it we used a Spinco model R apparatus, although, with suitable adjustment of voltages and times, any strip-type electrophoresis apparatus may be used.

Differentiation of glucose, galactose, fructose, and lactose in deproteinized human blood is facilitated by the use of borate solutions at two different *p*H's—an extension of the techniques of Consden and Stanier (*2*). The method will indicate concentrations as low as 4 mg per 100 ml of any one of these sugars in blood, equivalent to less than 4 μg per spot (*4*). It is satisfactory up to a total sugar concentration of about 125 mg per 100 ml; above this concentration the sample should be diluted to prevent streaking.

Reagents. Buffer A (*p*H 9.2) consists of a 2 percent aqueous borax ($Na_2B_4O_7 \cdot 10\ H_2O$) solution. Buffer B (*p*H 7) consists of 24.8 g of boric acid (H_3BO_4) and 5.8 g of sodium chloride, dissolved in water and diluted to about 700 ml. Borax solution (0.05*M*) is added, with stirring, until the *p*H reads 7.0. The solution is then diluted to 1 liter with water (*2*). Standard sugar solutions consisting of 1

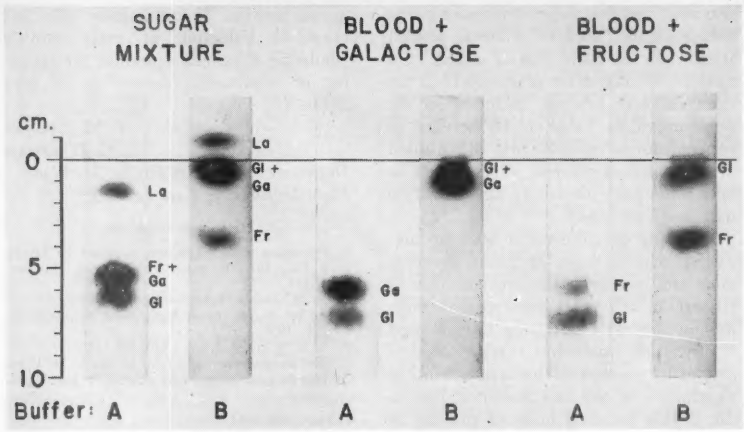

Fig. 1. Typical strips illustrating the separation of glucose (Gl), galactose (Ga), fructose (Fr), and lactose (La) in a standard sugar mixture and the separation of added galactose or fructose from the glucose of normal blood.

percent (weight by volume) aqueous solutions of reagent-grade glucose, galactose, fructose, and lactose, respectively, and of a mixture containing all four sugars, are used as controls. On the standard strips, 2 μl are used per sample. The aniline hydrogen phthalate bath used consists of 930 mg of redistilled aniline and 1.66 g of phthalic acid, dissolved in a solution of 5 ml of water in 95 ml of acetone. This solution, used as a bath, proved far superior to sprays based upon various alcohols.

Method. Heparinized blood (0.1 ml per determination) is pipetted into 2 ml of ice-cold ethanol (95 percent) and chilled in ice water for 15 minutes to precipitate the proteins. The mixture is then centrifuged (at 2000 rev/min) for 5 minutes. The supernatant liquid is decanted into a 2-in. petri dish and evaporated to dryness in a vacuum. The residue is taken up in 50 μl of water in a micropipette (*4*) and is applied to the mid-point of a paper strip (3 by 30 cm) and air-dried. The strip is mounted on the apparatus with the applied spot at the apex and is wetted carefully with buffer on each side, just below the spot, in accordance with Durrum's technique (*5*). After 1 hour is allowed for equilibration, an electromotive force of 210 v is applied for 4 hours. The strips are then dried, dipped in the aniline hydrogen phthalate bath, and suspended in an oven at 125°C for 10 minutes. Compact, stable, brown spots indicate the presence of the sugars.

Under these conditions, when buffers A and B are used in turn, the sugars migrate, as indicated in Fig. 1. Comparison with control strips indicates the presence, or absence, of glucose, galactose, fructose, or lactose in the blood sample. Heavy streaking of the spots indicates either insufficient equilibration time or too concentrated a sample.

The method has been applied to a large number of blood samples, and no interfering substances have been encountered in either normal or galactosemic blood. To date, neither fructose nor lactose has been found naturally in any sample (*6*).

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References and Notes

1. H. M. C. Robinson and J. C. Rathbun, *Can. J. Biochem. and Physiol.* 35, 935 (1957).
2. R. Consden and W. N. Stanier, *Nature* 169, 783 (1952).
3. For leading references see A. B. Foster, *Advances in Carbohydrate Chem.* 12, 81 (1957).
4. Although not quantitative, the recovery from 0.1 ml of blood is adequate to complete the determination of a 4-mg per 100 ml. sample; 2 μg of sugar, applied directly to the paper, gives a visible spot on development.
5. E. L. Durrum, *J. Am. Chem. Soc.* 72, 2943 (1950).
6. We are indebted to the department of biochemistry and pathological chemistry, University of Western Ontario, London, Ontario, for technical aid in this study and to the Department of National Health and Welfare, Ottawa, for financial assistance.

16 January 1958

On the Nature and Color of the Moon's Surface

The interstellar dust particles presumably responsible for the reddening of distant stars may consist largely of random aggregates of unsaturated and free-radical molecular species rich in carbon, nitrogen, and oxygen (*1*, *2*). By theoretical and empirical analogy with similar terrestrial species it has also been shown that such particles would need to have diameters only of the order of 20 A or less in order to absorb strongly in the visible region of the spectrum (*3*), since with such dimensions the average gap for allowed transitions between randomly filled Fermi levels is of the order of 3 ev. The random geometric and magnetic anisotropy of such particles also appears adequate to account for the polarization associated with interstellar reddening.

Particles of such properties and sizes differ considerably from the chemically stable or closed-shell dielectric and ferroelectric particles about 0.5 μ in diameter which are classically postulated for the interstellar dust. To give the same optical effects, the free-radical particles can be of the order of 200 times smaller in linear dimensions and 10^7 times smaller in total bulk than the dust particles required by approaches based only on classical metallic and dielectric scattering theory. Even if chemically stable dielectric or metallic particles should be formed, laboratory experience suggests that, under high-energy collisions and ultraviolet light, the particles in interstellar space would soon come to resemble radiation-damaged material, with randomized structures highly absorbing in the visible region.

These arguments should apply not only to particles but also to large airless surfaces in space if they are poor in hydrogen—perhaps, for example, the surface of the moon or of the planet Mercury. Whatever the original composition of the underlying material or its overlying interplanetary dust-fall, the surfaces we see may be extensively damaged by radiation and highly absorbing in the visible region. Even if there is progressive healing of the damage with ionic recombination and formation of renewed stable bonds during the hot lunar day, laboratory experience suggests that it may not be complete, especially when ultraviolet radiation is also present during the heating.

This prediction of surface disorder and opacity, possibly accompanied by porosity in layers of recombined dust, would help account for two perennially striking properties of the moon's surface: (i) the generally low albedo of the moon (and Mercury), about 7 percent, which has previously been taken as evidence that the surface resembles our blackest terrestrial rocks, slates, and basalts; (ii) the low thermal conductivity even on high lunar surfaces that might be expected to be free of loose dust. [Gold (*4*) has mentioned "radiation-induced coloration" but seems to suppose that it is negligible "in the denuded (eroded) highlands."]

Surfaces of such a chemically unstable character could also be highly reactive, and extensive exothermic reactions might be easily triggered, as in the Donn-Urey explanation of cometary outbursts (*2*). The first man who plants a rubber boot on a lunar surface may be in for an unpleasant surprise. This suggests a number of possible experiments as well as a num-

ber of precautions for early moon missiles. The gettering action of such a porous reactive surface may also be important in the final disappearance of any original lunar atmosphere.

Meanwhile, there are several laboratory experiments that would throw light on these questions. It would be worthwhile to study the changes in the reflectivities and other surface properties of common rocks and of carbon-, nitrogen-, and oxygen-containing compounds when exposed to high-energy particle radiation, ultraviolet radiation, and heating cycles. Such studies would have to be made under the most stringent vacuum conditions to avoid disturbances from oxygen-recombination effects. A comparison of the results with various lunar reflectivities might then make possible the closer identification of lunar rock species (*5–7*).

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References

1. B. Donn, *Mém. soc. roy. sci. Liège, sér.* **4**, 15, 571 (1954).
2. B. Donn and H. C. Urey, *Astrophys. J.* **123**, 339 (1956).
3. J. R. Platt, *ibid.* **123**, 486 (1956).
4. T. Gold, *Monthly Notices Roy. Astron. Soc.* **115**, 585 (1955).
5. I am indebted to J. Lederberg and D. B. Cowie (*6*) and to H. C. Urey (*7*) for letting me see their manuscripts on related subjects in advance of publication.
6. J. Lederberg and D. B. Cowie, *Science* **127**, 1473 (1958).
7. H. C. Urey, "On the composition of the lunar surface," in preparation.

6 May 1958

Functional and Structural Observations on Chronically Reserpinized Monkeys

The effects of reserpine on the behavior of monkeys and chimpanzees were noted as reversible phenomena, resembling those encountered in human Parkinsonism—namely, hypokinesia, lethargy, mask-like face, muscular rigidity with "cogwheel" quality, sialorrhea, and tremors at rest (*1*). Even though experimental animals recovered completely from any ill effects shortly after the interruption of reserpine medication, and although no anatomical changes have hitherto been reported, it would be surprising if the profound neurological aberrations that occur in the course of prolonged medication had no anatomical counterparts in the central nervous tissue. The clinicoanatomical study described in this report was carried out on two adolescent female African green monkeys kept under reserpine (*2*) medication for 18 months and one male monkey given reserpine for 2 days and kept for 2 years without any drugs.

The first female received 0.5 mg of reserpine per kilogram of body weight intramuscularly daily for 238 days. Spontaneous activities lessened (*3*). Tremors at rest were frequently observed about 4 hours after each daily dose, lasting for several hours. Increasing the dosage to 0.75 mg/kg led to the appearance of some muscular rigidity. Reserpine administration was discontinued for 14 days. During the first 4 days of this interval the monkey still exhibited tremors at rest; during this entire period spontaneous activity remained less than it had been prior to the experiment. Administration of the drug was then resumed, at dosages of 0.2 to 0.4 mg/kg daily for 160 days. Tremors reappeared on the second day, becoming almost continuous and quite violent toward the end of this period. Treatment was again interrupted for 5 days, during which time the tremors disappeared but the activity level remained low. Treatment with reserpine was resumed at a dosage of 0.4 mg/kg; the dosage was gradually increased to 0.8 mg/kg and continued at this level until the experiment was terminated, after a total of 615 days. During this last period of treatment the animal developed what amounted to "status tremoris."

The second female was given reserpine daily for 512 days. Doses larger than 0.6 mg/kg led to some rigidity and hypokinesia (*3*). Doses as low as 0.3 mg/kg maintained the animal in a state of reduced activity and almost continuous tremor at rest. The drug was withheld for 5 days and then the animal appeared normal, with no tremors. Treatment was resumed at a dosage of 0.6 mg/kg; dosage was increased to 0.7 mg/kg and continued at this level until the experiment was terminated, after a total of 552 days.

The three animals were killed by the perfusion fixation method (*4*). Postmortem examinations revealed no gross abnormalities of visceral organs, brains, or spinal cords.

Microscopic examination revealed normal histological and cellular structures in the central nervous system of the monkey that was given no reserpine for 2 years.

The brains and spinal cords of the two chronically reserpinized monkeys showed no signs of hemorrhages, infarcts, softening, demyelination, glial reaction such as gliosis, or activation of histiocytes with phagocytosis. The cerebellum was notably free of any indication of change, all elements being well preserved and well stained.

Neuronal differences between the two chronically treated animals and the one which had had no drug for 2 years were clearly evident in some parts of the brain, especially in the cerebral cortex, basal ganglia, and brain stem. Conspicuous cytological changes involved the neuronal nucleus and nucleolus. A considerable number of the nuclei were markedly enlarged and pale. The pallor of the nuclei was caused by what appeared as a hole in the karyoplasm. These holes varied in size, and each had a scalloped periphery, as though some substance had been removed in the histological preparation. The nucleolus was located in the karyoplasm and stained lightly with gallocyanin at *p*H 1.7. The chromaphil bodies adherent to the nucleolus were slightly smaller in the two reserpinized monkeys than in the animal that had been given no drug for 2 years. Considerable variation from cell to cell and in different regions of the brain was observed.

The fact that neither severe changes nor loss of neurons was observed suggests reversibility of the process. However, the significance of these observations is as yet not known. In man, somewhat similar nuclear changes have been reported in insulin shock (*5*), anoxia (*6*), and so on. These have been ascribed to a process of vacuolization of the nucleolus (*7*). In the study discussed in this report, no vacuolization of the nucleolus was demonstrated. In keeping with the current concepts that nuclear-nucleolar activities are involved in protein metabolism of neurons (*8*), the results given here indicate that during chronic reserpine medication, cell metabolism is influenced at all levels of the nervous system. Furthermore, this cellular response is not specific to the monkey; we have identified similar nuclear changes throughout the brains of cats subjected to powerful reserpine treatment. The ubiquitous effect on the nervous system is consistent with the wide range of symptoms which these animals exhibit, but we would hesitate to correlate this morphological alteration with any specific symptom. Although many of the cerebral neurons were involved, we observed no marked changes in temperament and "personality." Whether the changes represent a primary effect of reserpine on neurons or a secondary effect through other systems cannot be settled on the basis of the present morphological observations. It is noteworthy that the neuronal changes did not appear predominantly in the brain stem and basal ganglia, in contrast to the pathological changes in *paralysis agitans* and postencephalitic Parkinsonism.

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References and Notes

1. W. F. Windle *et al.*, *Am. J. Physiol.* **183**, 674 (1955); ———, *Federation Proc.* **15**, 202 (1956); ———, *Anat. Record* **124**, 474 (1956); J. Joralemon and W. F. Windle, *ibid.* **127**, 493 (1957); W. F. Windle *et al.*, *Trans. Am. Neurol. Assoc.* **81** (1956), 69 (1957); E. R.

Feringa and W. F. Windle, *Excerpta Med.* Sect. VIII 10, 104 (1957).
2. A preparation (Rau-sed) produced by E. R. Squibb & Sons was employed.
3. A motion picture film of the experimental animals is available from this laboratory on a loan basis.
4. H. Koenig, R. A. Groat, W. F. Windle, *Stain Technol.* 20, 13 (1945).
5. F. Kobler, *Arch. Psychiat. Nervenkrankh.* 107, 688 (1938).
6. J. Pichotka, *Beitr. pathol. Anat. u. allgem. Pathol.* 107, 117 (1942).
7. W. Höpker, *Acta Neuroveget.* (*Vienna*) 15, 14 (1957).
8. L. Einarson, *Am. J. Anat.* 53, 141 (1933); H. Hydén, *Acta Physiol. Scand. Suppl. 17*, 6, 1 (1943).

3 February 1958

Turbidity Currents and Displaced Fresh-Water Diatoms

Kolbe (*1, 2*) called attention to an abundance of displaced fresh-water diatoms in deep-sea cores of the eastern Atlantic Ocean. He considered three possible theories to explain this distribution of such out-of-place floras. The theories considered are: potamic or ocean-current theory, aeolian theory, and Atlantis theory (modified from Malaise, *3*). The first two are tenable, and we feel that an additional possible method of distribution of the forms should also have been considered, that of distribution by turbidity currents.

Evidence of oceanic turbidity currents has been presented by Heezen and Ewing (*4*), Erickson, Ewing, and Heezen (*5*), Kuenen (*6*), and many others. Perhaps among the better documented ones is the movement associated with the Grand Banks earthquake, described by Heezen and Ewing (*4*). Other evidence has been pointed out by Andrée (*7*), who noted that Atlantic submarine cables are most frequently broken during the rainy seasons along the African and South American coasts. This would support the inference that sediments move along the ocean bottom in turbidity-current or slump fashion.

Several examples of displaced foraminiferal faunas appear in geologic literature. Phleger (*8*) described a displaced fauna from a deep-sea core consisting of shallow-water foraminifera and, lower in the core, sand containing twigs, nuts, and bark fragments of dicotyledonous bushes and trees. Phleger (*9*) concluded that "Deep-sea sands, having only shallow-water species, are believed to have moved down as a unit without contaminating other sediments," thus inferring movement by turbidity currents. Natland (*10*) concluded that turbidity currents are of considerable importance in distribution of microfossils.

Turbidity currents are considered to be common features of the continental slopes and of all other major submarine slopes. Evidence of them in the area described by Kolbe (*1, 2*) can be found in deep-sea cores. An interesting deep core taken from the Romanche Deep shows interbedded sand of angular fragments of mafic rocks, clay, and silt, with occasional streaks rich in organic remains (Pettersson, *11*). The lower part of the core consists of calcareous ooze. Recently published photographs (*12*) of the floor of the Romanche Deep show the coarse texture of particles at the surface. Pettersson (*11*) concludes that the general area is tectonically active, supplying brecciated rock fragments to slumps which moved down the steep slope into the Romanche Deep. Core No. 238, mentioned by Kolbe (*1, 2*), occurs in the deep and contains an abundance of displaced diatoms.

Diatomaceous cores studied by Kolbe (*1, 2*) fall into two categories or areas—those east of the Mid-Atlantic Ridge, in which diatoms were common in many horizons, and those west of the ridge, in which diatoms occur only at individual horizons and even there are relatively uncommon. Core No. 246 is practically at the crest of the ridge and contains *Melosira granulata* at a single horizon. Although this form is by far the most abundant one in cores east of the ridge, it does not occur west of the ridge, as reported in Kolbe's tabulation (*2*). Fresh-water species do occur in cores on the ridge and in cores No. 255 and 267 west of the ridge. Floras of the last two localities have nothing in common with those east of the ridge, according to Kolbe's tabulation (*2*), and certainly seem to have been derived from a different source. Generalizations that suggest a single source and homogeneity of the flora seem unwarranted.

A distribution other than by oceanic currents is suggested for these fresh-water forms in view of the above distribution. Lohman (*13*) concluded that the settling time of diatoms through three miles of sea water must be measured in hundreds of years. It would thus seem improbable that a current of moderate velocity, such as the equatorial Atlantic currents, could selectively distribute the fresh-water diatoms in the pattern documented by Kolbe (*2*). A more localized phenomenon is suggested, one in which the diatoms were probably part of the flocculent of fine sediments which forms at the mouths of most major streams as they enter the sea, a flocculent which then moved downslope with the entrapped diatom flora without contamination by contemporary marine forms and without contamination of the normal oceanic currents.

If the displaced diatoms were brought into the area of the Cape Verde basin either by wind of the Harmattan haze or by oceanic currents, distribution of diatoms through thick sequences of sediments would be expected to be more constant than Kolbe infers. The relatively slow rate of sedimentation and the near constancy of wind and oceanic currents over hundreds of years would tend to produce a constant or nearly constant supply of organic material through time. On the other hand, turbidity currents can disrupt the average rate of sedimentation and can deposit relatively thick layers of near-shore material into the deeps at irregular intervals. It would thus be possible to deposit nearly pure, near-shore displaced faunal and floral elements in thick layers in deep water in a very short time. Because of this marked variation in assumed depositional rate, it seems unlikely that rate of sedimentation is a reliable means of telling geologic ages, even back to the Tertiary.

Turbidity currents might explain the concentrated occurrence of diatoms in the cores mentioned by Kolbe (*1*) (Nos. 229, 230, 234, 235, and 238), for all these cores occur in deeps east of the Mid-Atlantic Ridge or on the continental slope west of Africa.

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References and Notes

1. R. W. Kolbe, *Science* 126, 1053 (1957).
2. ———, "Diatoms from equatorial Atlantic cores," in *Report of the Swedish Deep-Sea Expedition* (Göteborg, 1955), vol. 7, fasc. III.
3. R. Malaise, *Sjunket land i Atlanten* (Ymer, Stockholm, 1956).
4. B. Heezen and M. Ewing, *Am. J. Sci.* 250, 849 (1952).
5. D. B. Ericson, M. Ewing, B. Heezen, *Bull. Am. Assoc. Petrol. Geologists* 36, 489 (1952).
6. P. H. Kuenen, *Marine Geology* (Wiley, New York, 1950); *Am. J. Sci.* 250, 874 (1952).
7. K. Andrée, *Geologie des Meeresbodens* (Borntrager, Leipzig, Germany, 1920), vol. 2.
8. F. B. Phleger, F. L. Parker, J. F. Peirson, "North Atlantic foraminifera," in *Report of the Swedish Deep-Sea Expedition* (Göteborg, 1953), fasc. II.
9. F. B. Phleger, "Displaced foraminiferal faunas," *Soc. Econ. Paleontol. Mineral. Spec. Publ. No. 2* (1951).
10. M. L. Natland, "Treatise on Marine Ecology and Paleoecology," *Geol. Soc. Am. Mem. No. 67* (1957).
11. H. Pettersson, *The Ocean Floor* (Yale Univ. Press, New Haven, Conn., 1954), p. 94.
12. J.-Y Cousteau, *Natl. Geograph. Mag.* 113, 373 (1958).
13. K. E. Lohman, "Geology and Biology of North Atlantic Deep-Sea Cores Between Newfoundland and Ireland," *U.S. Geol. Survey Profess. Paper No. 196* (1942), pt. 3.

17 April 1958

Rigby and Burckle do not believe in my suggestion No. 3 (*1*) based on Malaise's theory (fresh-water diatoms found in deep-sea sediments of the Atlantic but originating in a fresh-water biotype, which subsequently became submerged) and ascribe the layers of these diatoms, as in core No. 234, to the action of turbidity currents.

Rigby and Burckle suggest that fresh-

water diatoms from the mouth of African streams were entrapped in fine sediments, "a flocculent which then moved downslope. . . ." Is it possible that this flocculent mass could travel with a turbidity current and be deposited at a distance of more than 900 km from the African coast? This seems highly improbable, and, to my knowledge, there are no records to support this hypothesis. Regarding the breaks of submarine cables off the Great Banks in 1929, which Rigby and Burckle mention, the Swedish oceanographer B. Kullenberg (*2*) has pointed out that the breaks could not have been caused by turbidity currents but must have been caused by the earthquake itself because, among other evidences, one cable broke simultaneously in two different places.

Even if we should accept the faint possibility of a turbidity current flowing from the African coast and dumping its load of fresh-water diatoms at a distance of 930 km from this coast, it remains to be explained how it was possible for this current not only to carry its load such a distance but, at the same time, to climb uphill more than 1000 m before dumping the load on top of a submarine hill. Core No. 234, with its fresh-water diatom maximum, was taken at a depth of 3577 m, and depths between the coring point and the African coast were measured to 4586 and 4967 m.

I think that Malaise's theory (*1*) explains the phenomenon in a far more plausible way than the hypothesis of Rigby and Burckle.

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References

1. R. W. Kolbe, *Science* **126**, 1053 (1957).
2. B. Kullenberg, *Deep-Sea Research* **1**, 203 (1954).

22 May 1958

Effect of Calcium on Deposition of Strontium-90 and Calcium-45 in Rats

As the principal hazardous constituent of the radioactive fallout from atomic bomb tests, strontium-90 has been the object of much recent study with respect to its progression along the food chain from soil to plant to animal, and eventually to man. In nearly all of these studies, attention has been directed to the comparative behavior of strontium and calcium, the rationale being that strontium and calcium, because of their close chemical similarity, will behave similarly in biological processes. If one can determine the extent to which strontium and calcium differ in their behavior at each step in the food chain, the Sr^{90}/Ca ratio of the material at the end of the chain can be readily deduced from the Sr^{90}/Ca ratio at the beginning of the chain. Since the calcium concentration in human bone is physiologically controlled within rather narrow limits, the Sr^{90}/Ca ratio will be a measure of the actual Sr^{90} concentration, and thus a measure of the potential hazard.

This approach to the problem is exemplified by the work of Comar and associates, who have studied the comparative behavior of calcium and strontium in rats, cattle, and man, for all of the steps in the progression of these elements from plant material to human bone (*1*). By applying such data to the over-all Sr^{90} hazard problem, it has been estimated that the Sr^{90}/Ca ratio will be reduced from 6- to 12-fold in the passage from contaminated vegetation to human bone (*2*).

In applying this procedure to the evaluation of the Sr^{90} hazard, the question arises whether the discrimination between strontium and calcium at any step in the food chain may be properly considered as a constant, or whether this discrimination may actually vary considerably, depending upon environmental and physiological factors. The experiment described in this report was designed to study the effects of dietary calcium level and the duration of the feeding period on the ratio of Sr^{90}/Ca^{45} deposited in the bone of rats.

Three groups of 16 mature female rats were maintained for 30 days on diets containing 0.5 percent phosphorus, and 0.1, 0.5, or 2.0 percent calcium (*3*). After this 30-day conditioning period, Sr^{90}, Ca^{45}, and insoluble Cr_2O_3 labeled with Cr^{51} were added to the diets. Four animals from each group were sacrificed after 3, 6, 13, or 24 days on the labeled diet. One femur and a blood sample were assayed for Ca^{45} and Sr^{90}. Total calcium and phosphorus were determined in the second femur. Food consumption (Sr^{90} and Ca^{45} intake) was estimated from measurements of Cr^{51} in the total feces and contents of the gastrointestinal tract from the animals in each experimental group.

Food consumption was essentially the same on all three diets, and weight changes during the course of the experiment were negligible. Results of total calcium and phosphorus analyses indicated no significant effects of the dietary regimens on gross bone composition.

The Sr^{90} and Ca^{45} concentrations in the femur, expressed as percentages of daily intake per gram of bone ash, and the ratios of these percentage concentrations, are shown in Table 1. Within each dietary group there was an evident trend toward lower values for the Sr^{90}/Ca^{45} ratio as time on the labeled diet increased. In view of the small number of animals involved, the significance of this trend may be questioned, particularly in the higher calcium level groups. There can be no question, however, that the Sr^{90}/Ca^{45} ratios are a function of the dietary calcium level. While the content of both Sr^{90} and Ca^{45} in bone varies inversely with dietary calcium level, the effect is quantitatively different for the two isotopes and is not simply proportional in either case. Reducing calcium five fold, from 0.5 to 0.1 percent of the diet, increased the percentage retention of Ca^{45} by a factor of approximately four, at all time periods, but increased Sr^{90} retention by a factor of only two to three. Increasing calcium four fold from 0.5 to 2.0 percent of the diet decreased

Table 1. Effect of dietary calcium level on Sr^{90} and Ca^{45} concentrations in bone.

Ca content of diet (%)	Time on labeled diet (day)	Percentage daily intake per gram bone ash*			Milligrams of dietary calcium deposited and retained per gram of bone ash*
		Sr^{90}	Ca^{45}	Sr^{90}/Ca^{45}	
0.1	3	2.6 ± 0.6	13 ± 2	0.20 ± 0.02	1.2 ± 0.2
0.1	6	5.8 ± 0.9	30 ± 6	0.19 ± 0.02	2.3 ± 0.5
0.1	13	9.4 ± 1.6	64 ± 9	0.15 ± 0.02	5.8 ± 0.8
0.1	24	10.9 ± 2.3	88 ± 15	0.12 ± 0.01	9.3 ± 1.6
0.5	3	1.3 ± 0.3	4.1 ± 0.9	0.32 ± 0.10	1.9 ± 0.4
0.5	6	1.9 ± 0.3	7.3 ± 0.8	0.26 ± 0.02	3.1 ± 0.4
0.5	13	3.3 ± 0.9	14.3 ± 3.5	0.23 ± 0.01	6.3 ± 1.6
0.5	24	5.0 ± 0.6	21.8 ± 3.3	0.23 ± 0.02	10.3 ± 1.5
2.0	3	1.3 ± 0.5	2.4 ± 0.8	0.55 ± 0.09	4.4 ± 1.5
2.0	6	2.1 ± 0.2	4.7 ± 0.5	0.45 ± 0.03	7.5 ± 0.7
2.0	13	2.8 ± 0.3	6.3 ± 0.8	0.44 ± 0.01	11.8 ± 1.5
2.0	24	4.6 ± 1.8	11.4 ± 4.2	0.41 ± 0.02	23.2 ± 8.5

* All values: average of four animals ± one standard deviation.

the percentage retention of Ca^{45} about twofold, while having no significant effect on Sr^{90} retention.

The last column of Table 1 shows the total calcium derived from the diet, which is deposited and retained during the course of the experiment. These figures are calculated from the measured Ca^{45} concentration in the bone and the known ratio of Ca^{45} to stable calcium in the diet. While rather close physiological control of dietary calcium utilization is evidenced at the two lower dietary levels, this control is no longer very effective at the 2-percent calcium level.

Blood levels of Sr^{90} and Ca^{45} at different times of sacrifice were reasonably constant within a given dietary group. Between dietary groups, the blood levels of Sr^{90} and Ca^{45} varied in essentially the same manner as their concentrations in the femur. In general, for a given group of animals, the ratio of Sr^{90}/Ca^{45} in the blood was not significantly different from the ratio of Sr^{90}/Ca^{45} in the bone; this suggests, as others have pointed out (*2*), that the major discrimination between dietary calcium and strontium does not occur in the specific processes of deposition on the bone. Because total calcium analyses on blood were not obtained, and in view of the limited time period studied, closer intercomparison of the blood and bone data with a view toward elucidating discrimination mechanisms would not seem to be justified.

Wasserman *et al.* have recently described an experiment in which Sr^{90} and Ca^{45} were chronically administered with diets varying in total calcium content from 0.5 to 2.0 percent (*4*). The skeletal deposition of both Sr^{90} and Ca^{45} in their experiment was inversely proportional to the calcium content of the diet. A number of differences between the experiments of Wasserman *et al.* and those which we report may have contributed to the different results obtained. Perhaps the most significant of these differences is the constant Ca/P ratio which was maintained in all diets by Wasserman *et al.* The increase in phosphate levels may have contributed very significantly in decreasing the availability for absorption of both the Sr^{90} and Ca^{45}. Changes in Sr^{90}/Ca^{45} ratios with time were not observed by Wasserman *et al.* (*4*). Although they varied the period on the experimental diets from 15 to 45 days, Sr^{90} and Ca^{45} were present in the diets for only the final 7 days of each exposure period. Effects due to differing turnover rates of Sr^{90} and Ca^{45} in bone would not, therefore, have been observed.

Should it develop that the ratio of strontium-to-calcium retention in bone does indeed vary with dietary calcium level under conditions which would normally apply in the human being, this would have an important effect on the evaluation of the Sr^{90} fallout hazard. Results from the present experiment suggest that the variation in hazard due to uneven distribution of fallout may be more closely related to actual Sr^{90} concentrations than to the much wider range of Sr^{90}/Ca ratios (*5*).

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References and Notes

1. C. L. Comar, I. B. Whitney, F. W. Lengemann, *Proc. Soc. Exptl. Biol. Med.* 88, 232 (1955); C. L. Comar, R. H. Wasserman, M. M. Nold, *ibid.* 92, 859 (1956); Atomic Energy Commission Document ORO-133 (1954); C. L. Comar *et al.*, *Proc. Soc. Exptl. Biol. Med.* 95, 386 (1957).
2. C. L. Comar, R. S. Russell, R. H. Wasserman, *Science* 126, 485 (1957).
3. The basic diet consisted of: Sucrose, 62 percent; casein 20 percent; alphacell, 10 percent; butterfat, 4 percent; vitamin mixture, 2 percent; Ca-free salt mixture, 2 percent. The calcium content was adjusted by addition of calcium lactate.
4. R. H. Wasserman, C. L. Comar, D. Papadopoulou, *Science* 126, 1180 (1957).
5. This paper is based on work performed under contract No. W-31-109-Eng-52 for the U.S. Atomic Energy Commission. The technical assistance of Joan Hess is gratefully acknowledged. A more detailed account of this and related studies is in preparation.

21 April 1958

Acanthamoeba: Observations on Animal Pathogenicity

The occurrence of *Acanthamoeba* in tissue cultures of trypsinized monkey-kidney cells has been observed by Jahnes *et al.* (*1*). We have isolated, from a similar source, an amoeba tentatively classified as *Acanthamoeba* which we have found to be pathogenic for mice and monkeys.

The amoeba first was recognized in the lesions of animals dead from the inoculation of a tissue-culture fluid thought to contain an unknown virus, but which later was shown to contain only *Acanthamoeba.*

Following intracerebral and intraspinal inoculation into cortisonized monkeys, extensive choriomeningitis and destructive encephalomyelitis occurred, causing death of the monkeys in from 4 to 7 days. Intracerebral injections into mice produced destructive encephalitis, causing death in 3 to 4 days. Many amoebae were found in the lesions at the site of inoculation, but it was obvious that the amoebae had migrated through the meningeal spaces and also through the tissue spaces of the brain and spinal cord.

To date, a few experimental observations have been made by injection of the cultures of amoebae into mice by other routes. Intravenous injection of the amoebae results in perivascular granulomatous lesions about amoebae that evidently escaped from the pulmonary capillaries. Intranasal instillation in mice lightly anesthetized with ether results in a fatal infection in about 4 days. These mice exhibit ulceration of the nasal mucous membrane with direct invasion of the adjacent base of the skull and involvement of the frontal lobes of the brain. The presence of many amoebae in the lungs is associated with a severe pneumonic reaction, with extensive fibrinopurulent exudate containing polymorphs and monocytic cells. Hemorrhage is a common feature. Pulmonary veins are invaded, and there are numerous thrombi containing many amoebae. Sections of the kidney show that the amoebae are present in the glomerular capillaries.

These observations suggest a possible explanation for the presence of the amoebae in the monkey-kidney culture and indicate that further inquiry into the possible role of the *Acanthamoeba* in disease processes is desirable.

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Reference

1. W. G. Jahnes, H. M. Fullmer, C. P. Li, *Proc. Soc. Exptl. Biol. Med.* 96, 484 (1957).

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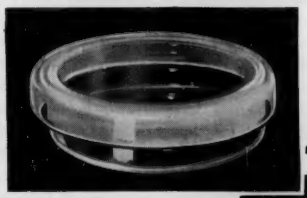

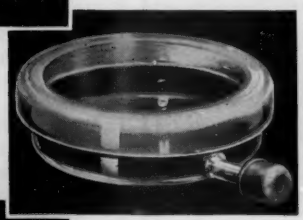

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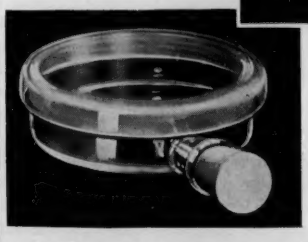

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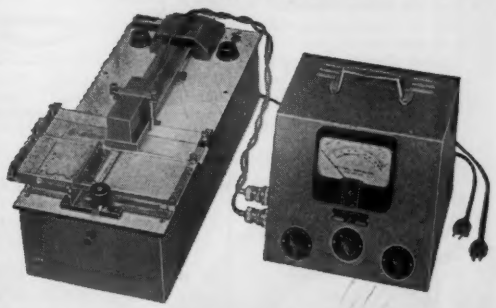

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Cosmic Radiation and Space Travel

The problem of radiation as a hazard for future space travel has received much public discussion recently. Comments have been heard to the effect that (i) there is no need to put human beings into space, as necessary observations may be made better by instruments, and (ii) there is, in any case, no major danger from the levels of radiation that are expected to be encountered. Regarding the first point, it is certainly true that early observations not requiring the exercise of human judgment can be made much more simply by the use of instruments alone. However, it is virtually certain that man eventually *will* be put into space, and probably for prolonged periods of time.

On the second point, uncertainty about the nature and occurrence of radiations in space and about the biological effects of such radiations (particularly with respect to the heavy primary cosmic-ray particles) is such that much further study will be necessary, both on the ground and in flight tests, before the risk from these radiations can be fully assessed. One reason for this uncertainty is that there are no accelerators now available or even definitely planned, as far as we know, which would be capable of producing particles in the laboratory analogous to the heavier high-energy ones found in primary cosmic rays. Unlike most other phenomena involved in space travel (low gravity, high accelerations, stress, and so on) and except for the slower-moving ones, these high-energy radiations are a phenomenon that cannot be engineered out of a space vehicle by any technique presently known.

An informal meeting on "Biological Effects of Cosmic Rays and Accelerated Heavy Ions" was held 21 and 22 Jan. 1958 at the Donner Laboratory of the University of California for the purpose of discussing the present status of knowledge of biological hazards of cosmic radiations and of planning avenues of research leading to more definite knowledge of the fundamental biophysical processes involved and their relation to future space travel. The meeting was sponsored jointly by the Space Biology Branch of the Aero-Medical Field Laboratory, Air Force Missile Development Center, Holloman Air Force Base, New Mexico, and the Donner Laboratory of the University of California. The participants included the following: G. Adams, University of California Medical School; R. G. Allen, School of Aviation Medicine, Randolph Air Force Base; A. C. Birge, P. H. Flanders, H. B. Jones, H. C. Mel, R. K. Mortimer, H. G. Parker, C. A. Tobias, and D. C. Van Dyke, Donner Laboratory; C. D. Clemente, University of California (Los Angeles); I. Cooper and H. H. Mitchell, Rand Corporation; H. B. Chase, Brown University; R. Fox, E. L. Hubbard, and E. M. McMillan, University of California Radiation Laboratory; E. Goodpasture, W. Haymaker, and I. J. Lebish, Armed Forces Institute of Pathology; W. Hild, University of Texas Medical School; D. Mazia, University of California (Berkeley); E. C. Pollard, Yale University; H. J. Schaefer, U.S. Naval School of Aviation Medicine; D. G. Simons, Holloman Air Force Base; W. S. Stone, University of Texas; H. Yagoda, National Institutes of Health; M. R. Zelle, U.S. Atomic Energy Commission.

Discussion sessions were held on the following subjects: Physical nature, intensity, and variations of primary cosmic rays and experimental methods available for biological studies; effects (lethal, metabolic, developmental, and genetic) of cosmic rays and low-level radiation on unicellular organisms; effects of cosmic rays and low-level radiation on animals (acute and delayed physiological effects; effects with respect to carcinogenesis and longevity); nuclear rockets; effects of radiation on nerve and brain tissue; and future investigations with heavy ions.

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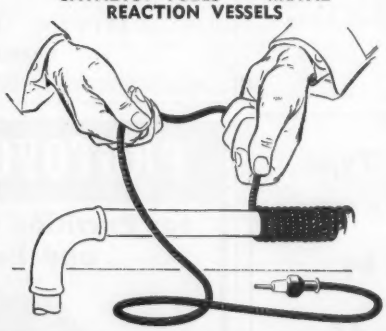

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The general recommendations of the meeting may be summarized as follows: Additional studies are necessary and should be made, both at ground level and in flight, on the physical properties, dosimetry, and biological effects of cosmic rays, fundamental work to be carried out first at ground level whenever possible. It is particularly important to have coordinated and simultaneously determined physical and biological measurements. Biological studies should be conducted on the unicellular, tissue, animal, and eventually human, levels, and both acute and chronic biological effects should be considered, the latter being perhaps the more important.

Previous studies suggest that radiation damage from cosmic-ray primaries may be of most consequence, or may differ most from damage from more conventional radiations, (i) in regions where damage to a few cells may be biologically amplified to affect many cells, as with germ plasm or when homeostasis is upset (from hypothalamic damage, for example); (ii) when the cells affected do not have the ability to regenerate (as in various parts of the central nervous system); (iii) where a single particle may inactivate a whole group of cells necessary for biological function (white hair formation on black mice is an example); or (iv) where partial cell irradiation may lead to an increased incidence of nonfatal but deleterious effects, such as carcinogenesis.

For making physical measurements on primary cosmic rays, vertical sounding rockets, balloons, and satellites all have their place. For measurements outside the earth's magnetic field, magnetic-polar-region flights or orbits several earth diameters distant will be needed.

Accelerator work on dose response and relative biological effectiveness of the various radiations on a variety of biological materials should be continued and expanded, with nuclei identical to or closely analogous to those occurring in cosmic rays. It appears theoretically possible at present to accelerate artificially the very heaviest of such nuclei, and a long-range research viewpoint may eventually require this. To this end some of our very largest accelerators could be adapted to biological experimentation, or new accelerators could be built if the prospective work load for biological and physical experimentation required it.

For biological experimentation, continuation of balloon flights is desirable both for measuring the actual effects on special biological materials near the top of the atmosphere (including studies of carcinogenesis and longevity) and for gaining experience in handling techniques in problems of closed environment. Satellites offer some special advantages for longer experiments and will become increasingly valuable when satellite recovery becomes feasible.

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A more detailed program of investigation was recommended for the near future. Work on certain of these projects is now, or is expected soon to be, under way. This includes studies involving use of the new heavy-ion linear accelerator of the University of California Radiation Laboratory, which is now producing beams of carbon, nitrogen, oxygen, and neon ions at 10 Mev per nucleon. Yale University now has a similar accelerator in operation, which may participate in this program. [For more information, see C. A. Tobias, H. C. Mel, D. G. Simons, Eds., *A Summary of the Berkeley Conference on Biological Effects of Cosmic Rays and Accelerated Heavy Ions*, Univ. Calif. (Berkeley) Radiation Lab. Publ. No. 8201 (10 Mar. 1958).]

As for hazards to personnel, a human being in a space ship removed from the earth's magnetic field might expect to receive mean doses of around 140 millirads per week. The relative biological effectiveness is not known for some of these particles, but since they have dense tracks one might find the primary rays many times as effective as low-energy x-rays, for at least some effects. Space flights of only a few weeks' duration probably will not involve a great radiation health hazard unless regions are found in space with radiations of unusually high intensity or effectiveness (recent press reports indicate that the Explorer satellites may have located some such regions). The use of nuclear-powered craft may also introduce a significant new factor of radiation exposure. In flights where long-time exposures are involved, such as in colonization of the moon and planets, the biological effects of cosmic-ray primaries may well be a limiting factor.

Because of the complexity of the biological and physical problems and the elaborate instrumentation involved in these investigations, they can be considered only as a large and long-term research effort. Furthermore, progress in this field must be based on cooperation and free exchange of information between scientists of several disciplines and various service groups.

C. A. Tobias
H. C. Mel
D. G. Simons
Donner Laboratory, University of California, Berkeley, and
Aero-Medical Field Laboratory, Holloman Air Force Base, New Mexico

Forthcoming Events

July

25–29. Chromatic Discrimination in Animals and Man, ICSU symp., Paris, France. (H. Pieron, Collège de France, Place Marcelin-Berthelot, Paris 5e.)

28–30. Regulation of Cell Metabolism, Ciba Foundation symp. (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

28–2. Home Economics, 9th intern. cong., College Park, Md. (Congress Director, American Home Economics Assoc., 1600 20 St., NW, Washington 9.)

28–8. Statistical Summer Seminar, Dedham, Mass. (I. Weiss, Bell Telephone Labs., North Andover, Mass.)

August

4–9. Microbiology, 7th intern. cong., Stockholm, Sweden. (F. C. Harwood, Soc. of American Bacteriologists, c/o Waverly Press, Inc., Mt. Royal and Guilford Aves., Baltimore 2, Md.)

7–9. Electron Microscope Soc., annual, Los Angeles, Calif. (C. M. Schwartz, Battelle Memorial Inst., 505 King Ave., Columbus 1, Ohio.)

10–16. Radiation Research, intern. cong., Burlington, Vt. (H. M. Patt, Argonne National Lab., P.O. Box 299, Lemont, Ill.)

11–13. International Mathematical Union, 3rd general assembly, St. Andrews, Scotland. (F. Smithies, Mathematical Inst., 16 Chambers St., Edinburgh 1, Scotland.)

11–16. Occupational Therapists, World Federation's 2nd intern. cong., Copenhagen, Denmark. (Mrs. I. Worsoe, Hvidkovervej 10, Aarhus, Denmark.)

12–13. Economic Botany Conf., New York, N.Y. (D. J. Rogers, New York Botanical Garden, Bronx Park, New York 58.)

13–15. Electronic Standards and Measurements Conf., Boulder, Colo. (J. F. Brockman, National Bureau of Standards, Boulder.)

13–15. Industrial Applications of X-ray Analysis, 7th annual conf., Denver, Colo. (W. M. Mueller, Metallurgy Div., Denver Research Inst., University of Denver, Denver 10.)

13–19. Seaweed Symposium, 3rd Intern., Galway, Ireland. (C. O. hEocha, Chemistry, Department, University College, Galway.)

13–20. Insect Pathology and Biological Control, intern. conf., Prague and Smolenica, Czechoslovakia. (J. Weiser, Inst. of Biology, Nacvicisti 2, Prague XIX, Czechoslovakia.)

13–20. International Astronomical Union, 10th general assembly, Moscow, U.S.S.R. (P. Th. Oosterhoff, IAU, Leiden Observatory, Leiden, Netherlands.)

15–20. World Medical Assoc., 12th general, Copenhagen, Denmark. (World Medical Assoc., 10 Columbus Circle, New York 19.)

17. American College of Hospital Administrators, 24th annual, Chicago, Ill. (ACHA, 620 N. Michigan Ave., Chicago 11.)

17–21. Health Conf., 7th annual, University Park, Pa. (M. Cashman, Pennsylvania Dept. of Health, P.O. Box 90, Harrisburg.)

18–19. American Astronautical Soc., Western meeting, Palo Alto, Calif. (N. V. Petersen, Lockheed Missile Systems Div., Palo Alto.)

18–21. Conservation Education Assoc., 5th annual, Salt Lake City, Utah. (S. D. Mulaik, Biology Dept., University of Utah, Salt Lake City.)

18–21. Heat Transfer, AIChE conf., Evanston, Ill. (F. J. Van Antwerpen, AIChE, 25 W. 45 St., New York 36.)

18–22. Clinical Chemistry Workshop, Houston, Tex. (Division of Clinical Chemistry, Dept. of Biochemistry, Baylor Univ., College of Medicine, Houston 25.)

18–22. Occupational Medicine and Toxicology, 2nd Inter-American conf., Miami, Fla. (W. B. Deichmann, Dept. of Pharmacology, Univ. of Miami School of Medicine, Coral Gables, Fla.)

18–22. Plant Science Seminar, 35th annual, Big Rapids, Mich. (E. P. Claus, Div. of Pharmacy, Ferris Inst., Big Rapids.)

18–22. Semiconductors, intern. conf., IUPAP, Rochester, N.Y. (D. L. Dexter, Dept. of Physics, Univ. of Rochester, Rochester.)

18–23. New England Assoc. of Chemistry Teachers, 20th summer, Kingston, R.I. (J. A. Martus, College of the Holy Cross, Worcester 10, Mass.)

18–25. Religion in the Age of Science, 5th summer conf., Star Island, N.H. (Institute on Religion in an Age of Science, 280 Newton St., Brookline 46, Mass.)

20–23. Photofluorography, intern. cong., Stockholm, Sweden. (International Cong. of Photofluorography, P.O. Box 5097, Stockholm 5.)

20–27. Australian and New Zealand Assoc. for the Advancement of Science, 33rd cong., Adelaide, Australia. (J. R. A. McMillan, Science House, 157–161 Gloucester St., Sydney.)

20–27. Genetics, 10th intern. cong., Montreal, Canada. (J. W. Boyes, Dept. of Genetics, McGill Univ., Montreal.)

21–23. American Farm Economic Assoc., Winnipeg, Canada. (L. S. Hardin, Dept. of Agricultural Economics, Purdue Univ., Lafayette, Ind.)

21–23. Chemical Organization of Cells, Normal and Abnormal, Madison, Wis. (J. F. A. McManus, Dept. of Pathology, Univ. of Alabama Medical Center, Birmingham.)

21–24. Cenozoic of Western Montana, field conf., Missoula, Mont. (A. E. Wood, Soc. of Vertebrate Paleontology, Dept. of Biology, Amherst College, Amherst, Mass.)

23–25. Rural Sociology Soc., annual, Pullman, Wash. (H. F. Lionberger, Dept. of Rural Sociology, Univ. of Missouri, Columbia.)

24–28. American Inst. of Biological Sciences, annual, Bloomington, Ind. (H. T. Cox, AIBS, 2000 P St., NW, Washington 6.)

24–29. Atmospheric Diffusion and Air Pollution, intern. symp., Oxford, England. (F. N. Frenkiel, Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.)

24–29. Mental Health, world federation, 11th annual, Vienna, Austria. (Miss E. M. Thornton, World Federation for Mental Health, 19 Manchester St., London, W.1, England.)

24–30. Prehistoric and Protohistoric Science, 5th intern. cong., Hamburg, Germany. (Büro des Internationalen Kongresses für Vor- und Frühgeschichte, c/o Fremdenverkehrs- und Kongresszentrale, Hamburg 1, Bieberhaus, Hachmannplatz.)

(See issue of 20 June for comprehensive list)

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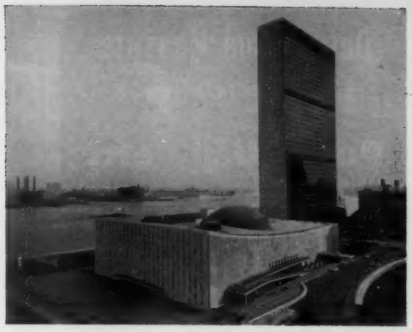

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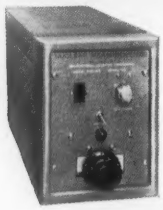

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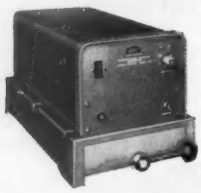

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Letters

Glucuronic Acid and Hyperbilirubinemia

The observation by Danoff *et al.* [*Science* **127**, 795 (1958); *Lancet* (8 Feb. 1958)] that administration of glucuronic acid and its sodium salt to infants with hyperbilirubinemia resulted in a striking but transient fall in unconjugated bilirubin is of extreme interest to all pediatricians. In our work with glucuronic acid we have been unable as yet to demonstrate a significant fall in bilirubin level. However, we wish to call attention to the potential hazard in the use of these preparations in view of the fact that physicians may be tempted to substitute glucuronic acid therapy for replacement transfusions in newborn infants with dangerously high serum bilirubin levels. Should the reported findings be confirmed, there is no indication regarding the fate of the declining serum bilirubin. The possibility has not been excluded that bilirubin is driven from the blood into the tissues, thus increasing the risk of brain damage.

Until further investigative work determines the exact pharmacodynamic action of these compounds, we feel strongly that physicians should refrain from using them in the newborn.

RUDI SCHMID
GLORIA JELIU
SYDNEY S. GELLIS
Boston City Hospital,
Boston, Massachusetts

Schmid, Jeliu, and Gellis comment as follows on our recent report dealing with the reduction of indirect bilirubinemia: (i) They state that they have not been able to duplicate our results. (ii) They suggest that we may be doing harm by driving bilirubin from the blood to the tissues, increasing the risk of brain damage. (iii) They urge all to desist from this therapy until further pharmacodynamic studies of glucuronic acid are carried out.

It would seem that the discrepancy between the results of the Boston workers and our own may be explained by differences in technique. This matter is now being explored. It would seem to us unfortunate if the concern of our Boston colleagues were to result in discontinuance of studies with this promising therapeutic approach.

It goes without saying that all new drugs should be thoroughly tested prior to clinical use and that they should not be used without due information in regard to their pharmacodynamic action. We might point out, however, that glucuronic acid, although not previously used for this particular purpose, is by no means a new drug. It has been known

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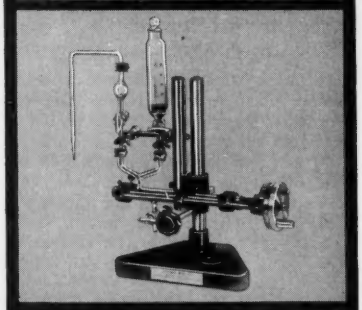

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for two generations, and its safe and toxic levels have been documented [N. E. Artz and E. M. Osman, *Biochemistry of Glucuronic Acid* (Academic Press, New York, 1950)]. There are numerous references dealing with its administration to experimental animals and to man.

Our critics do not document the basis of their expressed fear that by lowering the level of bilirubin in the blood we are driving it into the tissues. It was presumably based on two observations that have been recently reported—the finding of Silverman *et al.* [*Pediatrics* **18**, 614 (1956)] that certain sulfa drugs, notably sulfasoxazole, would facilitate the passage of bilirubin from the blood stream into the brain and the finding by Johnson, Sarmiento, and Day [*Trans. Soc. Pediatric Research* (1958), p. 63] that kernicterus occurred in five rats of the Gunn strain whose bilirubin was lowered by the administration of glucuronic acid.

We should like to point to evidence that glucuronic acid and sulfa drugs do not act similarly on bilirubin. Odell [*Trans. Soc. Pediatric Research* (1958), p. 147] has made in vitro studies of sera with a high bilirubin content. When sulfa drugs were added to such sera and the sera were ultrafiltered, the bilirubin passed out into the ultrafiltrate, presumably because the sulfonamide displaced bilirubin from combination with serum proteins. The addition of glucuronic acid to serum had no such effect. Regarding the Gunn rats, we do not question the observation that increased bilirubin concentrations of the tissues may have occurred. These rats, however, differ from newborn infants in several respects. Their skin was noted to become increasingly icteric after administration of glucuronic acid, whereas in our infants not only was a decrease in skin icterus observed but this was confirmed by measurements of the bilirubin specimens of subcutaneous fat obtained at biopsy before and after therapy. For these reasons and because of our favorable clinical experiences we do not share the fears that have been expressed.

STUART DANOFF, CHARLOTTE GRANTZ, AUDREY BOYER, L. EMMET HOLT, JR.
New York University College of Medicine, New York

Human Values

H. J. Muller's recent article [*Science*, **127**, 625 (1958)] on the evolutionary basis of human values was most interesting and informative. As one not trained in biological science, I certainly accept his interpretation of the evidence as authoritative. However, since he follows his scientific discussion by proposing a system of ethics, I think that I am no further afield in commenting on his ideas than he is in presenting them.

As a result of natural selection, Muller points out, species for which social living is helpful for survival develop natural tendencies and desires which promote the success of cooperative enterprises. Thus, such ideas as "brotherly love" have a basis in natural evolution. In human beings, then, these inherited tendencies mean that actions which advance the welfare of one's fellows—thus aiding the survival of the species—satisfy basic natural desires and are therefore emotionally rewarding. In addition, the culture based upon this natural heritage recognizes the need for cooperative actions and adds its own rewards and punishments. On the other hand, as a society grows large, individuals who do not have these genetic traits are no longer discriminated against but are helped by the society to adopt the necessary cooperative attitudes. This leads to a gradual dilution of the genetic basis of the cooperative society.

From these considerations, Muller proposes that a new system of ethics be adopted, based upon the idea that those actions which contribute to the survival and advancement of the species be regarded as good and praiseworthy and that opposing actions be condemned. Clearly, from the biological discussion it is necessary that any successful system of

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ethics include these features—ethics must be in harmony with nature—but it does not follow that they are a sufficient foundation for such a structure. Included in the basis of ethics must be a system of rewards for the individual who conforms. Inspiring phrases about the advancement of the species will probably have little appeal to the less educated, and perhaps even some educated nonbiologists may have misgivings as to whether the species is worth the trouble. Of course, those whose heredity gives them cooperative tendencies will find inner harmony from ethical and humane behavior, but such people are presumably becoming fewer. In the future we must place increasing reliance on culturally imposed motivation, and it seems unlikely that such forces could successfully oppose strong antisocial attitudes, perhaps arising from mutations, if these became widespread. Indeed, since we have been living for many generations in a fairly large and complex society, we ought already to see signs of the dilution of its genetic base. Nevertheless, recent times have shown a tremendous increase in the number of people and agencies engaged, and in the amount of effort and money spent, in aiding unfortunate persons. In short, recent history shows trends apparently in conflict with the idea of inherited traits as the only basis for society, and the ethics based solely on the advancement of the species seem to hold little hope for the future.

In view of these shortcomings, I, for one, am not inclined to join Muller's crusade to change man's concept of values in accordance with a "scientific ethics." Since science is basically concerned with what is "true" about nature and is therefore amoral, it seems unlikely that it can do more than lay down some necessary conditions for an ethical system.

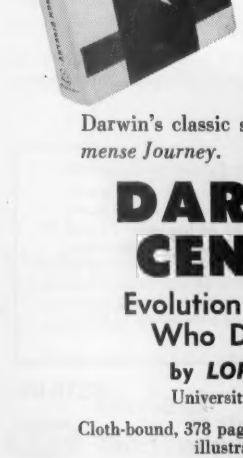
WALTER K. BONSACK
California Institute of Technology, Pasadena

Walter K. Bonsack's letter appears to say that if the evolutionary interpretation presented in my article were correct, genetic degeneration would today be, and would for some time past have been, overriding cultural improvement in regard to matters of morals and ethics, whereas it is obvious that, on the contrary, society is becoming increasingly socially oriented, in some areas at least. My article did not maintain that an actual retrogression of the genetic basis of moral conduct is occurring, although it did present grounds for the inference that there has been a falling off of its rate of advance. This may or may not be enough to constitute a retrogression. On this point far more factual evidence is needed. However, in any case, the rate of the genetic change must be several orders of magnitude lower than the present rate of cultural improvement.

The vastly greater speed of the cultural changes does not, however, cause the genetic process to be less important in the long run. In regard to this genetic process, it should be recognized that the fatalistic attitude of all past ages, that man can do nothing about his own hereditary constitution, is as unjustified and outmoded as a completely *laisser faire* economics.

Bonsack's final remark that science, being concerned with what is true, "is therefore amoral" exemplifies the widespread view that (as I put the case in my article) matters of value "cannot profitably be argued about." It was a major purpose of my article to bring forward evidence against this very view. However, as I pointed out in my introductory remarks, some persons are "irrevocably committed" to this position, and my discussion was not addressed to them. For there can, *ipso facto*, be no reasoning with them about these matters.

H. J. MULLER
Indiana University, Bloomington



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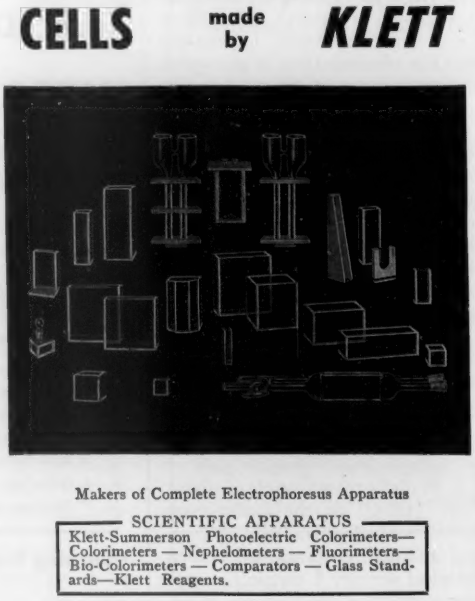

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■ DIGITAL VOLT-OHM METER gives direct numerical indication of a-c and d-c voltage and resistance. Voltage measurements are accurate to ±0.5 percent; resistance measurements to ±1 percent. Ranges are selectable in decades from 0 to 1000 v and from to 0 to 10 megohm. Sampling rates may be set at 1 to 10 per second or may be arranged for external triggering. Measurement is accomplished in the instrument by comparing the input voltage to a reference linear sweep voltage that is generated internally. Start and stop pulses thus obtained are used to control a gated oscillator. Frequency range is 50 cy to 50 kcy/sec. Polarity and decimal-point location are indicated. Binary-coded output is available for operating a digital recorder. (Beckman Instruments, Inc., Dept. 118)

■ STEREOSCOPIC MICROSCOPE for dual use permits both the instructor and the student to view the same field simultaneously. Thus the instructor may demonstrate and manipulate objects under stereoscopic observation without ambiguity. (Kenneth A. Dawson Co., Dept. 110)

■ OSCILLATOR covers frequencies from 180 to 600 Mcy/sec in a single range. A 4-in. dial is direct reading in terms of frequency with accuracy of ±1 percent. At least 300 mw of output power is available into 50 ohm at all frequencies. (General Radio Co., Dept. 114)

■ PARTICLE ACCELERATOR of Van de Graaf type is designed for pulsed neutron output. The instrument delivers 2.5×10^9 neutron/sec during a 100-μsec pulse. Energy rating is 0.25 Mev, nominal, with ion current of 50 μa during pulse. Pulse length is adjustable in the range 25 to 250 μsec. Pulse rise and decay times are less than 5 μsec. Repetition rate is 400 pulse/sec, synchronous with ion-source power supply. (High Voltage Engineering Corporation, Dept. 117)

■ ANGULAR-POSITION TRANSDUCER combines a rotary variable transformer and a transistorized demodulator. When the unit is excited from a suitable a-c source, the d-c output is linear with respect to rotation and polarized with respect to direction of rotation. A typical instrument range is 45-0-45 deg rotation. Units are available for excitation frequencies from 400 to 1000 cy/sec and with outputs up to ±30 v d-c. (Bourns Laboratories, Dept. 124)

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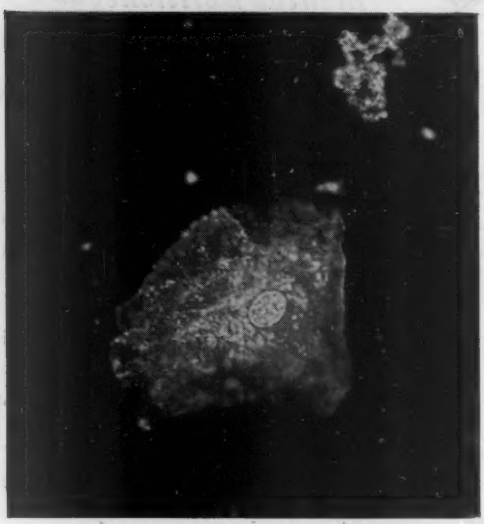

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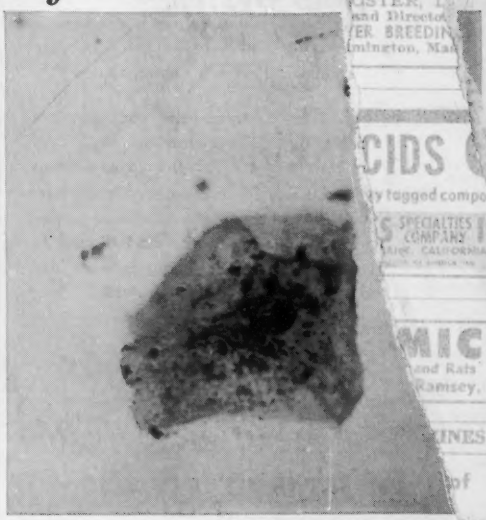

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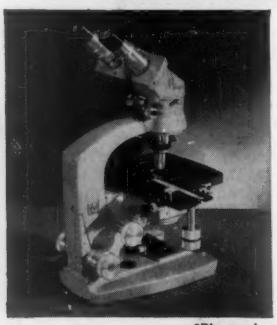

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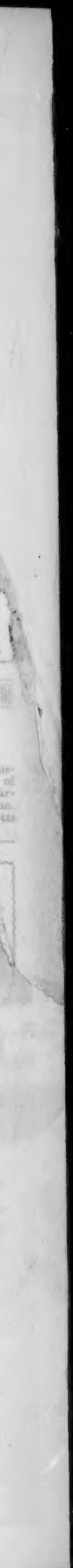
NAME_____

ADDRESS_____

CITY_____ ZONE____ STATE_____